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Chemist to the South Suburban Gas Company; Fellow of the Chemical Society
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EDITORIAL NOTES.

Purifier Inefficiency with the Direct Sulphate of Ammonia Process.

THERE have been anticipations that the practice of the recovery of ammonia by the direct process will extend on gas-works. The hitherto slow adoption has been largely due to the fear of the effects of sulphuric acid on the illuminating power of the gas; but now that the future qualitative standard of gas is to be the calorific power one, there is not the same strength attaching to the reticent attitude. Various gas-works have the direct process now in operation; but the adoption in some cases has been attended by a low sulphate of ammonia yield per ton of coal carbonized, and coincidently bad working of the oxide purifiers, while in other cases the sulphate yield has been good, and the purifiers have worked as satisfactorily as the best under ordinary circumstances. Although the direct process must not be blamed entirely without an investigation as to the nitrogen content of the coal and the carbonizing conditions, there is in the widely contrary experiences a nice problem for inquiry. Singularly, the problem has not been attacked by those chiefly concerned—that is to say, by those troubled with the ill-working of their purifiers and by low sulphate of ammonia yield. But it has been left to the Chief Inspector of Alkali Works (Mr. W. S. Curphey), who, with his assistants, is year by year raising by beneficial work the amount of the indebtedness of the gas industry to him. A considerable part of his annual report [*see* pp. 606-12] is devoted to a masterly statement of considerations affecting the question of bad purifier working and low sulphate yield with the direct process, and to the deductions drawn from those considerations, and from the chemical and working investigations that have been made.

In the first place, there is the question as to the low yields of sulphate of ammonia with the direct process—yields much below to just over 20 lbs. of sulphate per ton of coal carbonized; and the very best yield, where there is no trouble with the oxide purifiers, is the excellent one in gas-works experience of 28 lbs. Now if the direct system is to justify itself, it must show yields exceeding the best gas-works practice on the old method (with which there are works that to-day are obtaining a yield proximate to 28 lbs.); for with the old plan there are losses of ammonia by leakage in various ways that it was hoped to avoid by using the direct system. When the yield is such a poor one as some works with the direct system realize, then there must be a reason for it which has yet to be ascertained; for Mr. Curphey has not got to the root of the matter, nor does he help us much towards its elucidation. The Chief Inspector and the District Inspectors have other work to do besides carrying on investigations for the gas industry; and it would be unfair—especially when research should be made by those concerned in the actual working results—to expect it to be undertaken without intermission, as though it was the only subject with which the department has to deal. As a matter of fact, work of this kind is not compulsory; it is voluntarily taken in hand with the view of being of service to the concerns over which the department has supervision.

However, the question of the association of the introduction of the direct process with the interruption of the efficient working of oxide purifiers has been taken further; and though, again, Mr. Curphey would not have all his conclusions characterized as positive, he has undoubtedly supplied some very valuable material for guidance in respect of the efficient working of purifiers, and which will be of assistance in fathoming the curious experiences as to purifier inefficiency on the adoption of the direct process. In his report for 1911, Mr. Curphey discussed the question of the fouling and the revivification of oxide; and, in commenting on the subject, we remarked: "It is indisputable "that there is scope for further research on the question, "and that more exact knowledge than is now possible "regarding the effects of temperature, humidity, and the "presence or absence of air, and the activity of oxide in "purifiers would be of great service to the gas manager." It was not then thought that the development of the investigation of purifier efficiency would be made in connection with the adoption of the direct process of sulphate of ammonia working. But, so it has been; and the results are of value in connection with this to a large extent neglected subject. Certain hypotheses have been put forward as to the irregular working of the oxide purifiers upon the adoption of the direct sulphate process. One is the supposed complete abstraction of ammonia from the gas by the sulphuric acid, which would result in a neutral or acid condition of the oxide. But Dr. Fryer has investigated this point; and he finds that in no case has ammonia been found to be absent in the gas entering the purifiers, and, in general, the amount is in excess of the proportion that is met with in gas-works practice. At one time, too, it was thought quite possible that failure of the purifiers was due to the accumulation within the mass of oxide of a large proportion of secondary products—ferrous sulphate and iron disulphide—causing the oxide to assume a "sour" condition. This also has been proved to be an incorrect assumption. Those managers who have entertained the first-named view have attempted to improve the efficiency of their purifiers by increasing the supply to them of ammonia. They have obtained the result desired, but with a wasteful use of ammonia—seeing that, under proper conditions of temperature and hydration, practically a trace of ammonia suffices to maintain the efficiency of the oxide, and, as already mentioned, experiments have proved the presence where purifier inefficiency exists of sufficient ammonia with the direct process.

This shows that other causes must be sought; and the first ones that occur are those of temperature and moisture. Both by deduction and by actual investigation on works where good and poor purifying results are being obtained, and where curiously the direct process ammonia returns coincide with the adjectives "good" and "poor," there is every reason for believing that the irregular working of the purifiers is mainly due to the low temperature and excessive moisture of the oxide, which latter condition arises partly from undue exposure to the weather, and partly to the excessive humidity of the gas entering from the acid scrubber. Where bad results obtained, it was also found that the purifiers were open to the vagaries of atmospheric temperature, that revivification was carried on where the material was exposed to the driving rain, and that the material was very moist—the degree of moisture increasing with the cold weather. The exact contrary conditions prevailed where the purification results were good. The facts that the gas leaves the direct process plant at a relatively high temperature, and carries with it to the purifiers an amount of aqueous vapour, cannot but be prejudicial to the working of the oxide; and therefore it must be legislated for. The conditions, moreover, are aggravated by the intermittent working of the virgin liquor still at many of the works, which must be extremely disturbing to the purifying system, when a secondary scrubber fed with ammoniacal liquor is not interposed between the "acid bubbler" and the purifiers to cool the gas and equalize the amount of ammonia carried forward. Assuming the causes to be those set forth, the corrections necessary to secure improved purification results are plain; but in some cases their application would not be without considerable difficulty, more especially at this time. For instance, one cannot, at a moment's notice, make the structural alterations necessary to ensure that the temperature is not lowered by an undue exposure of the boxes, nor in all cases can the revivification of the oxide of iron have

immediate protection provided. But it is work that Mr. Curphey advises should be put in hand as early as possible. He suggests, too, that other rules to good working should not be applied hastily but gradually—not forgetting that the condition of the material itself changes with use. The moisture content of the purifying material should be carefully regulated to (say) from 8 to 10 per cent. Experience is required in connection with the direct sulphate plant of the use of drier oxides. The crude gas should also enter the purifiers cool and dry, and with a moderate and regulated amount of ammonia—say, 0·5 to 1 per cent. The temperature in the sulphiding zone should be such as will enable the gas to carry as vapour the whole of the moisture equivalent to the sulphuretted hydrogen absorbed—say 70° Fahr. (21° C.) The temperature in the oxidation zone should approximate to this; so that the water of hydration set free in the sulphiding zone and retained in the sulphided mass may be reabsorbed through the hydration of reformed ferric oxide, and not be carried away in the exit gas and lost to the system. Reference has already been made to the use of a washer fed with virgin liquor placed between the "acid bubbler" and the purifiers to cool the gas and equalize the supply of ammonia. A steam-pipe would be useful in regulating purifier temperature in the very cold weather. There are other conditions making for efficiency which are set out in Mr. Curphey's report, and which, quite apart from the effects of the direct sulphate process upon the temperature and moisture conditions of the purifiers, are of considerable value. There is too much leaving of purifiers to practically automatic running; and greater control should be exercised. And if the direct sulphate process is to make headway as an integral part of the gas-works system, then it must be proved to equal, if not to exceed, the best standards of present sulphate production per ton; and such control must be brought to bear upon its functions and effects that there is no detriment to the gas purification system.

Always in the Rear.

It is fair matter for wonder whether we shall ever get into a condition in the gas industry when there will be a representative organization with sufficient initiative about it, and with a proper status among other scientific and technical bodies, to receive the recognition that is due to an industry of the importance of that of gas supply. It has been pointed out before that the gas industry is always being left unrecognized in the rear, and that there can only be one reason for this. For the same reason that it is left unrecognized, it is missing opportunities, while a competing industry is displaying a vast amount of activity, and securing for itself credit and recognition which will stand to the good in the development of its interests in the future. That industry is not losing a single opportunity. We congratulate it upon its vigour, and upon the foresight of its men in appreciating that the work must be done in the present that is to ensure a larger future. While that industry is devoting attention to those larger interests, the gas industry is still leisurely moving round about the question of a central council, the birth of which will be the best of all evidence as to the insufficiency of past organization.

There was a large and influential meeting held last Wednesday at the Mansion House, to discuss and to give publicity to the question of trade policy after the war, with special reference to the engineering industry. The meeting was organized principally by the British Electrical and Allied Manufacturers' Association, with the co-operation of the British Engineers' Association, and the Engineering and Electrical Sections of the Chambers of Commerce; and, in all the daily newspaper reports published throughout the country, the chief organizations of the electricity industry received publicity. We have looked through these reports, and fail to find in them any trace of the gas industry being in any way identified with engineering, or in any way interested in the work appertaining to trade after the war. In the "Engineer," there is a long list of the organizations that were represented, and important ones they are. There is no mention in it of any such body as the Institution of Gas Engineers. We presume that the Institution had an invitation to be present. It may, for aught we know, have been represented at the meeting. But, if it was, nobody seemed in any way concerned to note the fact. Why is it? The Sulphate of Ammonia Association is mentioned in the "Engineer" report; and, from a communication in our "Correspondence" columns, it is seen that the Chairman (Mr. H. M. Thornton) of that live organization the Society of British Gas Industries, sent a communication to the organizers of the meeting couched in terms showing the appreciation of the members of the need of very complete organization and co-operation among men and in the industries, having regard to the nature of the work and the burdens of the future. The world has done with the past, and with old-fashioned procedure which is as much out of unity with present times as the four-wheeled cab or the old horse-drawn omnibus. Progressive organizations are not hiding their heads in these times, or allowing themselves to be in the rear. They are pushing forward, demonstrating to the world at large that they are willing and ready, and will do their part in connection with the "great push" in the national industrial work, despite the fortifications, the trench ramifications, and the barbed wire entanglements of the enemy rivals.

There is plenty for the gas industry to do in the way of making preparations for the future; but the policy of leaving things much to individual agency, and not utilizing to the full co-operative power and energy, with better initiative, and of allowing matters to take their course in the belief that good fortune will favour as it has favoured in the past, seem to persist. If the policy continues, the gas industry will have to pay very dearly for its present lethargy; for its rivals are gaining in strength through a commendable activity that is not apparent in the gas industry.

The Government and Coal Supplies Control.

The interview that Lord Milner, the Supervisor of the various Government Committees dealing with coal questions, had recently with the Executive of the Miners' Federation of Great Britain has resulted in a considerable amount of commotion. The miners' representatives were asked to treat the matter as confidential. But rumours got afloat; and, as is the habit of rumours, they soon expanded, and assumed the guise of authoritative and definite proposals. Newspapers discussed the matter, coalowners were interviewed and with one accord professed to know nothing of it, references appeared as to private meetings of miners' district organizations, and some of the coal miners' representatives were mum over the matter, but others, evidently under the bond of secrecy as to the source of information, gave a little indication as to what Lord Milner had in his mind. Matters got to such pitch that, possibly to calm the coal owners and merchants, an official statement was issued, which referred to the rumours as "certain misconceptions" as to "an alleged proposed scheme for Government control "of coal," and asserting that all Lord Milner has in his mind is closer co-operation between the various Government Committees dealing with coal questions, and that no change in Government policy is in contemplation. Lord Milner would not have had his interview with the miners' representatives for the fun of the thing; and there was something that he wanted to ascertain from them, which "something" was undoubtedly in connection with a development of the work he has in hand.

In the official report, while there was a denial of any change in Government policy, there was the safeguarding clause that "in the light of any new facts that may arise, "the Government cannot undertake that they will not find "changes necessary from time to time." Somehow or other Government official statements have a most unhappy way of treating other people as though they were a lot of children, and unable to add two and two together. The safeguarding clause is the bridge over which will possibly come a development if the coal trade cannot quash it. Supplementing it there have been one or two obviously inspired explanations, which hint that Lord Milner has in mind the formulation of a scheme for co-ordinating the work of the various Committees, but that it may be some little time before he can make formal report to the Government of a positive scheme. We are inclined to think there is more in it than mere co-ordination of the work of the Committees. In one reference to a meeting of a miners' organization, it was stated that, for the scheme of further control that his Lordship has in mind, it was necessary for him to ascertain whether, in connection with price limitations, he might rely on the miners not asking for an increase of wages, and also whether they would be prepared to accept a relaxation of the Eight Hours Act. If this be true, then there might be some ground for the following statement of a "Mining

Correspondent" in the "Yorkshire Post:" "The basis of "the negotiations has been the price fixed by the Coal "Price (Limitation) Act, of 4s. per ton above the pre-war "price, with an additional 2s. 6d. per ton for export coal. "The colliery owners in the various producing districts "would sell their output to the State at the rate fixed by "the Board of Trade; and the State would arrange with "the distributing trade as to prices at which the coal should "be sold to the public in the home market. The control "of coal supplies would give the Government an entirely "free hand as to the price at which coal should be sold "to Allied countries, according to the purposes for which "it was required."

An Exceptional Opportunity for Gas-Stoves.

In the good time coming, it is anticipated that the gas industry will be the main fuel suppliers of the country—that no solid fuel will be used without first passing for treatment through its hands and those of cognate industries, while gas will be the principal source of heat. When that time arrives, lighting and power will simply be appendixes of the industry's heating business. That is the anticipation; its realization is not going to be obtained without the gas industry exerts itself, and without it takes advantage of all opportunities for promoting progress to the goal. An exceptionally fine opportunity appears to be about to present itself, if any reliance is to be placed upon a report appearing in the daily press. It is stated that the National War Savings Committee are again going to bring their influence to bear in serving the economy of the country through domestic channels, and that a conspicuous feature of a leaflet that is shortly to be sent out will be the economy that can be effected through the saving of the value destroyed by the use of raw coal in the domestic grate. If only 28 lbs. of coal could be saved per week, in the 9 million households of the United Kingdom, during the eight months in which domestic heating is most in use, this would mean that 4 million tons of coal, or the products of this quantity, would be saved in a year. It is also stated in the newspaper forecast as to the possible line of action of the National War Savings Committee that "it is likely the use of gas-fires, instead of coal-fires, will "be recommended." The gas industry should not miss this opportunity; nor should it wait for the National War Savings Committee to issue their circular. It should go to the Committee at once, and assure them that the industry is prepared to put forth its best energies (if properly supported) to help in this matter; but it is no use promising this, if impediments are to be set up by Government Departments. Given the support, there could be no finer opportunity presented for making a splendid forward movement in domestic heating by gas; and nothing should be allowed to stand in the way of making the utmost use of such a special opportunity, the like of which may never recur. It is one of those opportunities over which it is worth while making some sacrifice, which can be accounted as a gilt-edged investment for the future.

Rendering Coal Smokeless and Increasing the Radiant Heat of Coal and Coke.

Mr. A. Rollason, of Nottingham (whose process for the liming of coal for increasing the production of toluol, reducing sulphur impurities, and producing other collateral advantages, has been much discussed) has branched out, as our "Correspondence" columns showed last week, into a new line of investigation, and claims good practical result, which it will be interesting to have put to independent proof. He has lately been inquiring whether it is not possible to render coal smokeless by, through chemical means, breaking up the hydrocarbon envelope of the vesicles of water vapour given off on combustion. The power of the hydrocarbon film to conduct heat into the vesicle of water prevents the film taking up and retaining sufficient heat for the dissociation of its molecules into their atoms, with the production of a condition of motion necessary for their union with the oxygen of the air; and consequently the hydrocarbons pass away with the water vapour unconsumed forming dense volumes of smoke. The line of his research has been to try to effect the neutralizing of the power of the carbon for conducting heat, and so liberating the water vapour at an early period of combustion; and this, he says, results in a higher temperature being attained—in some cases, as high as 350° Fahr. One important advantage of this is to enable lower grades of coal to attain higher temperatures on combustion, and so allow them to replace the best grades for manufacturing and domestic purposes. Mr. Rollason finds that the most reliable neutralizing agent is carbon dioxide, which, when added in the form of a pure finely ground amorphous carbonate ("Avidimax") gives the most satisfactory results. From supplementary information, we learn that, with only 2 per cent. added to a coal fire burning in an open grate, there was an entire absence of smoke, the fire gave out great radiant heat, and an economy of fuel resulted equal to 12 per cent., which could be saved either as fuel, or by an increased heating of the room air. On adding 3 per cent. to a coke fire, the same effects were realized in regard to radiant heat and economy, the latter of which for the same work was equal to 15 per cent. The "odour peculiar to burning coke was also absent." Adding "Avidimax" to boiler fuels realizes an increase in the volume of water evaporated, or effects an economy of fuel with normal working. If true, this should be of great advantage in popularizing the use of coke for steam-raising. The public will want a lot of convincing that the results claimed are realizable, in view of former attempts to palm off upon them sodium chloride for obtaining similar heating and economy effects. However, if successful, Mr. Rollason is doing something to cut the "smoke nuisance" out of our repertory of reasons as to why gas should be used for domestic heating purposes. His method, too, of securing an economy of coal for a given amount of heating is going the wrong way to work in respect of the economy now being sought, which aims at preserving, through carbonization, the valuable volatile constituents of coal now being consumed in the raw state for domestic and industrial purposes.

The Railway Settlement.

It is a great satisfaction that the dispute over the application for an increased bonus to the railwaymen has been amicably settled. To have had a general railway strike at this particular juncture would have been a disaster in connection with the war; it would have dislocated the country's work when the country can least afford to have it put out of joint; and it would have made the threatened rigours of the coming winter still more severe. Gas undertakings will be, among other industries, supremely thankful the trouble has been composed without any breach in organization and running, though the compromise raises the war bonus of all men above 18 years of age from 5s. to 10s., and of employees under 18 years of age from 2s. 6d. to 5s. There are some people who are disposed to censure the men for asking for the additional bonus at this time, more especially after the agreement of last October, under which it was decided that the settlement then effected should remain in force until after the Government had given notice to determine the present system of control of the railways. Nevertheless, public sympathy was strongly in favour of the men who, through their unions, entered into the settlement last October quite in the dark as to the duration of the war, and the trend that the prices of food and other necessaries was going to take. While there are some grades of railwaymen who are well paid, there are others who are poorly rewarded for their services; and they are now feeling this condition very acutely. At the same time, the claims to consideration were not, as represented by the amount of the increase sought, based upon a modest plane. However, compromise has once again succeeded.

The Monazite Sand Discovery in Travancore.

The announcement which is made in later columns of this issue, to the effect that the Public Trustee will be glad to receive tenders for a very large number of ordinary and preference shares in the Travancore Minerals Company, under the provisions of the Trading with the Enemy Amendment Act, 1916, draws attention to a controversy which has been taking place in the pages of the "Indiaman." Some months ago, our contemporary published an interview with Sir Thomas Holland; and this, as was stated in the "Journal," a subsequent writer claimed "might convey to a superficial reader the impression that the important deposits of monazite sand in Travancore were discovered by the Geological Survey of India, that the discovery was duly published in the 'Records of the Geological Survey,' and that it was entirely the 'result of the carelessness, or something worse, of English scientific men and

manufacturing technologists' that the deposits 'fell into German hands.'" Arguing that the facts are quite otherwise, this writer said these deposits were discovered by the German prospector Schomburg in 1909; and it was not until November of that year, after Schomburg's discovery, that the Geological Survey of India sent a member of the staff to examine the deposits, his report not being published until 1914—"five years after the Germans had secured at least a temporary monopoly of what has proved to be the richest deposit of monazite in the world." To this Sir Thomas Holland replied that the discovery of monazite was announced, and its importance was emphasized, four years earlier than the report of 1914, in a manner giving it far wider distribution than the later special report; that the original lessee was an English company registered in London in 1907; that the concession granted to the Company by the Native State covered only a part of the known deposits; that the original concessionaires privately negotiated for a transfer of their rights to a group including German interests before their lease was signed; and that Travancore, being a Native State with a Geological Survey of its own, is obviously beyond the jurisdiction of the Indian Geological Department." "The facts," he added, "that the English Company subsequently disposed of its chief rights, and that practically the whole of the output was absorbed by Germany, merely emphasize the point made in my conversation, that English technologists, being otherwise busy and prosperous, neglected many apparently minor chemical industries the national importance of which was not noticed until after the outbreak of war." This drew forth a retort from the writer of the article that, so far from the German capture of Travancore monazite being attributable to the apathy of the British manufacturer, "there can be no doubt that, if the Geological Survey of India had recognized that the Travancore sand was rich in monazite, and if the deposits had been properly brought to the notice of the various British firms interested, the Indian monazite supplies would not have fallen into German hands."

Financial Facilities for Trade.

The financing of commercial undertakings by banking institutions is one of those things which people have long been told are done better in a certain other country. Bankers here have been called conservative—often in forgetfulness of the limitations to which they are by the nature of their business subjected. The claims of shareholders, together with the fact that the banks do very well indeed already, do not dispose the directors to operations possessing in any degree a speculative flavour; and therefore they would hardly be inclined to regard favourably some of the business of a particular kind that will require to be undertaken by someone after the war. A State controlled institution would, it is felt, have greater freedom of action, and so in many quarters there has been a warm welcome for the report to the Board of Trade by the Committee appointed to investigate the question of financial facilities for trade. The Chairman of the Committee was Lord Faringdon, and what they had to consider was the best means of meeting the needs of British firms after the war, particularly with reference to the financing of large overseas contracts. Their conclusion is that there is ample room for an institution which, while not interfering unduly with the ordinary business done by the British joint-stock banks, by Colonial banks, and by British and Foreign banks and banking houses, would be able to assist British interests in a manner that is not possible under the existing conditions. The institution must, they say, be equipped with an up-to-date Information Department, which will necessarily play a large part in its usefulness and financial success. This might be called a *Bureau d'Etudes*, independent of the Commercial Intelligence Branch of the Board of Trade, but in close touch with it. Besides having a thoroughly capable staff, the Bureau would avail itself of the services of the eminent consulting engineers, consulting chemists, &c., of this country. The lines on which such an institution might be conducted are sketched out in the report, which concludes with the recommendation that a new bank called the British Trade Bank should, without delay, be constituted under Royal Charter, with a capital of £10,000,000. It should, the Committee say, inaugurate an Information Bureau on the lines indicated, and should endeavour not to interfere in any business for which existing banks now provide facilities. The Trade Bank should try to promote working transactions on joint account with other banks.

OBITUARY.

Mr. HENRY JAMES LUFF, whose death occurred on the 17th inst., at the age of 61 years, had nearly completed 24 years of service as Secretary to the Oriental Gas Company, Limited, having been appointed to the position in December, 1892. He died at Hampstead, after an illness extending over four or five weeks, and was interred last Wednesday at Elmer's End Cemetery.

Second-Lieutenant B. H. TOWNSLEY, younger son of the late Mr. R. H. Townsley, formerly Gas Engineer to the Leeds Corporation, is officially reported to have been killed in action. Lieutenant Townsley, who was only 22 years of age, enlisted at Vancouver two days after war broke out, and came over with the first Canadian Contingent. A year ago last April he was given a Commission in the West Yorkshire Regiment.

PERSONAL.

The many friends of the Worshipful Master of the Evening Star Lodge (W.B. J. Fred. Wicks) will be sorry to learn that he has received information from the War Office stating that his son, Second-Lieut. H. R. WICKS, has been wounded in action with the Salonica forces.

Mr. HENRY FOWLER, who has relinquished the position of Chief Mechanical Engineer to the Midland Railway Company, has this week taken up duty as Superintendent of the Royal Aircraft Factory at Farnborough. Last year he was appointed Deputy-Controller of Production at the Ministry of Munitions. Mr. Fowler, who was formerly Gas Engineer to the Midland Railway, is a member of the Midland Association of Gas Engineers.

At the last meeting of the Middlesbrough Corporation Gas and Electricity Committee which he will attend in the capacity of Manager of the gas-works, kindly remarks by members were addressed to Mr. DAVID TERRACE. The Chairman (Mr. J. Calvert) said that Mr. Terrace had guided the destinies of the works for a great number of years; and they all appreciated his services. They had still a lien on part of his time as Consulting Engineer; and he would be in charge of the erection of the No. 5 gasholder. They all hoped he had many more years before him. Alderman Archibald and Alderman Mattison joined in the tributes; the latter remarking that, though he had been one of the critics of the Manager, he had always recognized that Mr. Terrace had the interest of the Middlesbrough Corporation at heart. It must be pleasing to him to think that one of those he had trained was about to step into his place. Mr. Terrace expressed appreciation of the great kindness he had received at the hands of the Committee. Though still in the best of health he had, he said, passed the age of three score years and ten; and he felt it was his duty to give up the reins. The "North-Eastern Daily Gazette," commenting the following day on the matter, said: "The graceful tribute paid by the Mayor to Mr. David Terrace, who, after a lifetime's service, is retiring from the position of Gas Manager, will be cordially endorsed, not merely by the members of the Corporation, but by the large body of ratepayers and gas consumers to whose interests he has devoted his talents as an engineer with such marked success. If it was to the Mayor, as Chairman of the Gas Committee, that Middlesbrough owes the conception of the scheme for the utilization of blast-furnace gas for lighting purposes—a scheme which has effected a saving of many thousands of pounds per annum in municipal expenditure—the application of the scheme in its practical details, and the solution of the many technical problems involved, were to a very large extent thrust upon Mr. Terrace's shoulders; and the success which from the first moment has attended the scheme, speaks volumes for the high engineering skill and ability of the Gas Manager. Mr. Terrace is now retiring from active service; but the Corporation are fortunate in being able to retain his services in a consultative capacity, and in Mr. G. F. Blincoe, who succeeds him, they have a servant who, it is firmly believed, will justify his selection." Mr. Blincoe, the present Assistant Manager, assumes control on Oct. 1, at a commencing salary of £350 per annum; and Mr. Terrace becomes Consulting Engineer for two years, at £250 per annum.

National Insurance (Part II.) (Munition Workers) Act, 1916.

It will be remembered that, under decision No. 1564x, the Umpire decided that contributions are payable in respect of "workmen engaged on the repair (including cleaning) of gas-cookers, gas-fires, gas-boilers, and gas-radiators, and in the repair of gas-fittings." At the request of a deputation from the Institution of Gas Engineers who discussed the matter with him, the Umpire promised [*ante*, p. 338] to reconsider that part of his decision which relates to cleaning. He has, we learn from Mr. Walter T. Dunn (the Secretary of the Institution), now communicated his opinion that there is not sufficient justification for the modification of his decision. Contributions are therefore payable from Sept. 4, not only for those engaged on the repair, but also for those engaged on the cleaning, of gas-cookers, &c.

CALORIFIC STANDARD ACT APPLICATIONS.

Third Official List.

THERE has now to be added to the names given on pp. 432 and 494 of the "JOURNAL" the following list of applications received by the Board of Trade from Companies for Orders under the Gas (Standard of Calorific Power) Act, 1916. In all cases, with the exception of that of the Chester Gas Company (in which the figure named is 475 B.Th.U.), the calorific power proposed is 500 B.Th.U.

BATH GAS LIGHT AND COKE COMPANY.
BRIDLINGTON GAS COMPANY.
CAMBRIDGE UNIVERSITY AND TOWN GAS LIGHT COMPANY.
CHESTER UNITED GAS COMPANY.
HARROW AND STANMORE GAS COMPANY.
STRETFORD GAS COMPANY.
SWANSEA GAS LIGHT COMPANY.
WAKEFIELD GAS LIGHT COMPANY.

In addition to the Companies named above, applications for a calorific power standard of 500 B.Th.U. have, we are informed, been made to the Local Government Board, up to the present time, by the following Local Authorities:

BRADFORD CORPORATION.
KEIGHLEY CORPORATION.
LEEDS CORPORATION.
RAMSGATE CORPORATION.

A letter has appeared in the Press, by Mr. A. Partington, the Clerk to the Ilford Urban District Council, drawing attention to the applications being made by companies, and saying he will be pleased if the authorities concerned will communicate with him, "with a view to a meeting of representatives being convened in London at an early date to consider the advisability of concerted action to obtain protective clauses in the interests of the ratepayers of their respective areas."

PUBLIC LIGHTING CHARGES.

THE short communicated article on this subject that appeared in the last issue of the "JOURNAL" (p. 556) reminds us that the legal position in regard to public lighting charges is in a most unsatisfactory position, owing to the variety of concessory clauses that exist in Private Acts, having found their way there through agreement and to avert opposition, more than by the will of Parliament, inasmuch as the general law bearing on the subject is quite clear. Our contributor referred to section 24 of the Gas-Works Clauses Act of 1871, which governs the matter, and which states that the charge made for gas supplied to the public lamps is to be by agreement or arbitration, "regard being had to the circumstances of the case, and the price charged to private consumers." These quoted words imply that the supply of gas to the local authority for a public purpose, is to be a matter of mutual arrangement. It does not say that the price is to be less than that charged to the private consumers; and therefore, unless there is a special agreement, that is the price that may be charged. In the invaluable "Michael and Will," there is this comment on the clause: "A gas company is under no obligation under this Act to supply gas to the public lamps at a price less than that charged to the private consumers." Now this comment has stood unchallenged for ages (it might almost be said), for it appears in the last (the sixth) edition and in the two previous ones—the fourth having been published in 1894. Probably if we had at hand the earlier editions, the same words would be found. They would not have been continued in the sixth edition had any judicial interpretation been given in the meantime affecting the expression of the learned Counsel's opinion.

However, it is seen by the clause that it does contemplate mutual agreement; but it would be very difficult to lay down any general hard-and-fast principles, especially nowadays with competition facing, as to the lines to be taken in fixing a charge for the public lamps, seeing that circumstances alter so much—as between different districts and even in different parts of one gas-supply area. For instance, the public lighting of one part of a gas supply district may be open to the competition of electricity suppliers, another part may not be; in some districts the greater part of the public lighting has been handed over to the electricity department of the local authority, and only the unprofitable fringe left to gas; the district, too, may be a straggling one, involving a good deal more leakage, and greater costs where services other than the supply of gas are also rendered. Parliament, however, has always recognized that public lighting is a service that should be treated somewhat differently from that to ordinary consumers, though the circumstances of each case must be considered on their merits, and an agreement arrived at accordingly. The words already quoted from section 24 of the 1871 Act point to this; and so do those of that old-fashioned, and to-day absurd, clause that appears in several Private Acts, to the effect that "the undertakers shall not charge a higher price per 1000 cubic feet for gas supplied to any local authority than the lowest rate per 1000 cubic feet from time to time charged by them to any private consumer in the district." This clause was obviously put into the Acts by agreement. But this was in the days when gas was used only for lighting. Now under the diverse uses of gas, when large consumers for purposes other than lighting—cooking, power, and heating—can only be obtained and retained by special contract prices, the clause is extremely unfair. But some local authorities, who want their full pound of flesh, no matter how much circumstances have changed, are very loth to give up the clause. Hence the special discount provisions for public lighting that are sometimes given by arrangement to local authorities who are not unreasonable regarding the retention of the ancient clause as last quoted.

Our correspondent wants to know why local authorities should have special consideration for public lighting, in view of the fact that the demand comes on the peak of the load, that each lamp requires a special service and is individually a poor consumer, and that each service means an amount of leakage? The matter has been discussed before Parliamentary Committees, though it would be difficult now to give "chapter and verse." The undertaking has, it is submitted, a monopoly of the gas supply, it has the advantage of the use of the public streets, it is sometimes responsible for some public inconvenience in regard to road openings, and the public lighting is only one account. That is the specious argument; and, from our own point of view, no particular weight should attach to it. A gas company's undertaking is a *quasi*-public concern. It is there, under the control of definite statutes, for a public purpose. The greater its success, the larger the amount it pays in rates and taxes, and the cheaper (apart from the force exerted by competition in the same direction) it must supply at, under the financial restrictions laid down by Parliament. It is unfair to the general consumers that any great concession in respect of public lighting should be pressed for by the local authority; for a heavy concession means the retarding of the reduction of price to private consumers. The point as to the public lighting coming on to the peak of the load is not one over which anything can be said where the public lighting is an all-night demand. If it is a short-hour demand, the case is different. Our correspondent inquires, "What is a fair charge for gas for public lighting, having regard to the circumstances of the case and the price charged to private consumers in the district?" That is a poser, as the lines of this consideration of the matter show. We are afraid that the public lighting can only be treated on a business basis, and be bargained for the same as any other large contract; but there should be reasonableness on both sides, and neither should be so mean as to take an undue advantage of position—the one as the local governing body, and the other as the sole supplier in the district of the means that give the most reliable light, and the most penetrative light under the worst of atmospheric conditions. One thing is certain, that the Whitchurch (Salop) District Council are wrong [*ante*, p. 522] in claiming any definite rebate per 1000 cubic feet, unless the rebate is specifically stated in their agreement. To anything above a specifically stated rebate, they clearly have not, on the facts as stated, any legal title.

An Aid to Economy.

A National Economy Exhibition is being held at the People's Palace, Mile End Road, E. [and will remain open until next Saturday], for the purpose of imparting to those who visit it knowledge which is useful at any time, but doubly so under prevailing conditions. The exhibition is under the patronage of Her Majesty Queen Alexandra; and its arrangement was carried out by an Organizing Committee with Mr. C. J. Stewart, the Public Trustee, as Chairman. Attention is called to a number of ways in which saving may be effected; and of these, undoubtedly one of the greatest is in connection with cooking. It is, as Sir Lauder Brunton, Bart., M.D., F.R.S., points out in an address, of the utmost importance, if true thrift is to be practised, that food should be well cooked; while, at the same time, of course, the good cook will also make the most of the material at disposal, and will often be able to use things which would be entirely wasted by her less experienced sister. Therefore, practical cooking demonstrations constitute, quite rightly, one of the principal features of the exhibition. Those attending can see with what great convenience, and with what excellent results, gas may be employed for cooking; and the result should be to add still further to the popularity of the gas-cooker in the district. This is not the only way in which the claims of gas are brought to the notice of visitors; for the Commercial Gas Company have secured an excellent position facing the entrance; and on their stand they display gas appliances of all kinds, for cooking, heating, hot-water supply, and a number of industrial uses. They have also a good show of lamps, burners, and fittings; the excellent lighting making the stall the bright spot of the exhibition. On one or two other stands, gas-cooking devices are shown.

National Insurance (Part II.) (Munition Workers) Act, 1916.—The Umpire has decided that contributions are not payable in respect of workmen employed by coke manufacturers and engaged wholly or mainly in connection with the working of the coke-ovens, and not covered by decision No. 1763x [*ante*, p. 495].

ELECTRICITY SUPPLY MEMORANDA.

THERE were certain cynical people who at one time of day were in the habit of describing the members of the British Association as "British Asses." This was unkind, and totally uncalled for, as, if those who attended the annual meetings could not show that they had rendered any material amount of good to the world, they were quite harmless, and might have been allowed to go their way free from insult. But in later years an atmosphere of greater practicality has surrounded the proceedings. The sectional meetings are permeated more than hitherto with the thoughts, opinions, and experiences of men actually engaged in the world's work, and so are not as formerly almost exclusively occupied by the *savants*, and by men who dabble in science and in economic questions merely as a sort of hobby or as an incident in their life occupations. The change was particularly seen in the discussion on the Fuel Economy report at the recent meeting. The scientists were largely in the back ground; the men of practical experience were much to the fore. This shows that "Fuel Economy" has "taken on" among the men chiefly concerned; and this augurs well for the future. But even among these men who have thought about the subject, there are differences of opinion as to the plans that should be adopted to attain the goal. It is interesting and instructive to closely watch this movement—in fact, it is imperative to do so, for out of the chaos of information, schemes, and ideas, something concrete may eventuate, and everyone must be on the *qui vive* to see how (if at all) his interests will be affected, and to act accordingly. The gas industry is particularly concerned; it is intimately concerned, as will be shown, in the plans that are in the minds of some of the chief of progressive electrical engineers, who have their eyes on the future as well as on the generation and sale of electricity in the present. It was recently said by an electrical journalist that the gas industry had a well-defined policy in hand, which aimed at collaboration by the two industries, or would make the electrical industry dependent upon the gas industry, or put the control of the former into the hands of the latter. He had before him at the time some recent utterances of Mr. Charles Carpenter, D.Sc., and certain writing by Mr. F. D. Marshall; and he was evidently very disturbed over the large amount of sense that he found in the general aspects of their suggestions. Akin to these ideas are the views that were expressed at the meeting of the British Association when discussing fuel economy.

Greater Practicality at the B.A. Meetings.

All the speeches at the meeting bearing on the subject, started from the assumption that electricity generation in the future—cheap generation resulting in low-priced sale—must be by large generating units. Only into such units can means of maximum economy be introduced; they cannot be satisfactorily introduced into small units. This is Sir Charles Parsons' view; and he is not a man of mediocre intelligence upon questions relating to power. How is the realization of the large units to be achieved? It must be by systematic proceeding, or the promotion of economy in working may produce uneconomy by the waste of the millions of capital involved in existing plants. And the electricity industry cannot afford to be saddled with an enormous new capital on the top of the undischarged one. Mr. C. H. Merz displayed to the meeting his views as to what was the line of least resistance in attaining the large units. The first thing to aim at is the establishment in each industrial district of a common interconnected electrical power distribution system. This is the linking-up proposal looked at as a matter-of-fact scheme, and fairly simple of accomplishment if there were not such a lot of obstinate heads in the way, in the shape of members of local authorities and companies who prefer keeping their own interests wholly partitioned off from their neighbours. With this interconnection achieved, there would develop from it the erection of the most economical generating plant, in the best possible position. And so, it is thought, economy would be secured.

Large Generating Units and Economy.

But where is the best possible position? Some enthusiasts in the past have suggested that the best possible position would be close to the heads of the coal-pits, so that there would be no carriage to pay for coal. But, in the course of the discussion, Mr. R. A. Chattock, the Electrical Engineer of Birmingham, pointed out that there is a consideration that governs this matter that should not be overlooked—that is, the necessity for ample quantities of condensing water. Just consider his statement. The Midlands are not well supplied with rivers; and cooling-towers are necessary. The cooling-towers at the Birmingham generating-stations evaporate about 1 million gallons of water per day. The whole supply of water to Birmingham is only about 25 million gallons per day; and most of this has to be brought down from Wales. Now supposing a large generating-station fifty times the size of the generating plant at Birmingham erected in a colliery district with an insufficient local supply of water. Under such circumstances, it would be necessary to have water-works provided equal to the supply of double the total quantity of water used daily for the whole City of Birmingham. That is to say, if the Birmingham generating plant requires 1 million gallons of water a day for condensing purposes, and the generating-station pictured in imagination is fifty times the size, then this would mean that 50 million gallons of water would be needed daily for condensing use. The point is a very material one. Under such conditions, there would be very little economy. It would therefore be necessary for the stations to be where there is an abundant supply of water, of which all colliery districts cannot boast; and it would probably be nearly as cheap to transfer the coal to where there is water as to transfer the water to where there is coal. Large concentration schemes are not all plain sailing for all parts of the country. They have their limitations. This water supply question is one. Another is the expense of the huge trunk cables which would be required, despite the use of high electrical pressures. A further consideration is as to the propriety of these huge stations from the military point of view. Concentration is favourable to aircraft and bombs.

Pit-Head Stations and Condensing Water.

Fuel economy bulked largely in the discussion by the electrical engineers. The experts who are contemplating these big unit schemes are also looking for economy to the carbonization of coal, the extraction of bye-products, and the burning of gas under the steam-boilers. It is all so very simple. Mr. Merz is of the opinion that this is the direction of progress. Mr. W. B. Woodhouse, of the Yorkshire Power Company, says that development of carbonization must go hand in hand with power distribution by means of electricity; and he spoke of the scheme into which the Yorkshire Company have entered, whereby they are going to take fuel gas from a low-temperature carbonization plant, which is intended to produce smokeless fuel for domestic purposes—if householders will take it at a price corresponding with that of coal, and requiring a large additional space per ton for storage. Mr. Woodhouse thinks the low-temperature carbonization plan points to co-operation between colliery owners and electricity suppliers. In the course of an earlier discussion, however, Colonel Blackett (who is a colliery owner) said: "It is not the business of coal proprietors to go in for chemical manufacture at the collieries. It is done by large colliery owners who are ironmasters as well, and have their own steel-works to administer. This is all right; but they have never yet ascertained their economic position when producing all these different things." This does not much look as though the colliery owners want the additional work that would be put upon them by collaboration with the electrical industry in the manner proposed. It is significant that, in the discussion by the electrical men, they did not seem to remember there is such an enterprising factor in the country as the gas industry, with large carbonizing plants in existence and trained technical men at the head of them. For all the indication he gave to the contrary, it might be assumed that Mr. R. A. Chattock, the Electrical Engineer of Birmingham, has no knowledge of the existence of gas-works at Birmingham, carbonizing (we should say) about $\frac{3}{4}$ million tons of coal, and using much over $4\frac{1}{2}$ million gallons of oil per annum. Already in being is the large organization of the gas industry with which under conditions there could be collaboration in respect of fuel supplying development, But Mr. Chattock looks elsewhere. He quite agrees that greater economy could be obtained in the running of large generating-stations by means of the gasification of coal and the recovery of the bye-products; but to run such plant as part and parcel of a generating station is something that he does not relish. Some electrical engineers talk lightly upon this subject; few of them really realize what it means. Mr. Chattock appreciates that a very much larger area of land would be necessary at the generating-station, and that extensive works, and highly qualified management, would be required to carbonize the coal and recover the bye-products. In addition, if carried out on the enormous scale indicated by the discussion, every one of the products would represent practically a business in itself, and need an organization and a large staff. He thinks it is hardly fair to ask the electrical industry to take on all these duties in addition to supplying electrical energy. His idea therefore is to hand over the work to some other body, and leave the generating of electrical energy to electrical engineers. He thinks "some other body" should be provided, by forming an Association of coal owners and coal users. However, if ever these enormous schemes mature, the gas industry will either take a very large part in them, or it will have to take a back seat. It is not surprising that there was laughter when Mr. Dugald Clerk, D.Sc., suggested that, if electrical engineers succeed in doing all they hope, gas-engine builders and the gas industry will assuredly be wiped out of existence altogether. And, further, that there should have been endorsement of his remark as to the amplitude of space for both industries continuing a prosperous career.

The Electrical Industry and Coal Carbonization.

The "Electrician" has just been celebrating, by the publication of a voluminous number, its 2000th issue. We congratulate our contemporary on a career of good service to the electrical industry, and with all sincerity wish it "Many Happy Returns of the Day." Among the several articles of interest that the special number contains is one, by Mr. Clifford C. Paterson, of the National Physical Laboratory, on the "Evolution of the Electric Lamp." He skims the vast amount of work that has been done in this connection; and eventually ends on the gas-filled lamp, which has been pursuing its career under the pseudonym of the "half-watt" lamp. He

Evolution of the Electric Lamp.

mentions the fact that efforts are now being directed to the production of smaller units, and says there is little doubt that considerable advances will be made in the near future. In his opinion, however, it is most unfortunate that the very high temperature to which tungsten is capable of being carried cannot be obtained without the wastage of so large an amount of energy through the gas in the bulb. But for this, he believes that efficiences of several candles per watt would be possible. A table which he supplies (and which we take the liberty of reproducing) shows the progress that has been made in the development of the incandescent filament lamp:

Type of Filament.	Candles per Watt.	Approximate Filament Temperature.
Carbon (1880)	0·25	.. 1800°C.
Graphitized carbon (1906) . .	0·35	.. 1880°
Tantalum (1905)	0·50	.. 1950°
Osmium (1905).	0·60	.. 1980°
Tungsten (vacuum) (1906) . .	0·80	.. 2050°
Tungsten (gas filled) (1914) .	1·50	.. 2400°

The last line does not support the 2 candles per watt efficiency; and, in connection with intrinsic brilliancy, the temperature of 2400° C. points to an augmentation of efficiency being accompanied by a serious increase in defect in another direction

Radiant Boiling-Plates.

In connection with electric boiling-plates, we happen across the name of our old friend Mr. F. S. Grogan, formerly of "Tricity" fame, but whose services are now being devoted in another direction. It is remembered how proficient he was in baking jam tarts, and toasting wafers of bread by electricity. He now appears to be interested in the "Arora" electric boiling-plate. The "Electrical Times" has published particulars concerning the results of "tests" with the plate; but tests do not always receive confirmation in practice. The information starts off with the statement that the plate shows an efficiency of 40 per cent. and 57 per cent. when boiling water with the plate cold and hot respectively. We recollect that Mr. Grogan used to say all manner of funny things about the efficiency of the boiling-rings on the top of a gas-cooker, always (so far as memory enables us to state) conveniently forgetting that 6 cubic feet of quite ordinary town's gas will on combustion give as many B.Th.U. as a unit of electricity. However, the tests are described thus: "An ordinary tin kettle weighing 10 oz., and measuring 8 inches in diameter was filled with 3 pints of water at a temperature of 62° Fahr. Starting with the plate cold, and taking an average of 1540 watts, this quantity was raised to boiling point in 16 minutes. The power consumption, therefore, was 410 watt-hours, for the raising of the temperature of 3 pints of water through 150° Fahr., which gives an efficiency of 40 per cent. Starting with the boiling-plate hot, but with a kettle filled with 3 pints of water at 62° Fahr., the time taken to reach boiling point was 11½ minutes, the average rate of current consumption being 1530 watts. The power consumption in this case was, therefore, only 289 watt-hours, or an efficiency of 57 per cent." Why is such a high figure as 62° Fahr. used as the temperature of the water at the beginning? Probably it was taken from a tank exposed to the hot sun of a few weeks ago. The efficiencies are not high. The manufacturers of electrical appliances are adept at throwing stones, and pointing out the deficiencies of types of appliances that are not their own, but are in competition. There is the enclosed boiling disc. With it, when new, it is stated, an efficiency of 35 per cent. is not uncommon, used in conjunction with a special kettle or utensils with perfectly flat base. Loss of its plane surface by the vessel, or if the top of the disc buckles or particles of dirt get between the vessel and the disc, the efficiency drops off materially. How these makers love one another! But with the radiant type of heater buckling of the utensils (so the tale goes) is not accompanied by loss of efficiency, and there is no top plate to crack or become distorted. With the radiant type of heater, too, ordinary kettles and saucepans can be used. So the struggle proceeds in connection with water heating by the aid of electricity.

The Half-Year's Coal Production.

A White Paper issued by the Board of Trade last Wednesday gives figures of the estimated quantities of coal raised in the United Kingdom during the first two quarters of the present year, along with like particulars for the corresponding periods of both 1915 and 1914. For the three months to March, the quantity raised was 64,271,000 tons; this being 55,000 tons, or 0·1 per cent., less than in 1915, and 8,494,000 tons, or 11·7 per cent., less than in 1914. For the next quarter, to June 30, there was an output of 63,864,000 tons, which was 570,000 tons, or 0·9 per cent., more than in 1915, but 3,365,000 tons, or 5 per cent., less than in 1914. For the half year, the output of the mines (which includes the coal used for colliery purposes) was thus 128,135,000 tons, which compares with 127,620,000 tons for the same half of 1915, 139,994,000 tons for 1914, and 145,561,000 tons for 1913. Deducting the exports (including the coal equivalent of coke and manufactured fuel), the quantities available for consumption for the four half years named were: Six months to June, 1916, 107,203,000 tons; 1915, 104,026,000 tons; 1914, 103,604,000 tons; 1913, 108,282,000 tons. These totals include coal for use by the Admiralty or as bunker coal in merchant ships. Compared with July, 1914, the number of persons employed at coal mines at the middle of each of the first two quarters this year showed a mean decrease of 14·3 per cent.

ALKALI WORKS CHIEF INSPECTOR'S REPORT.

THE particulars given in last week's issue of the "JOURNAL" [p. 553] from the report for 1915 of Mr. W. S. Curphey, the Chief Inspector under the Alkali Works Regulation Act, 1906, are now supplemented by a few further figures, as well as, on other pages of this number, by sections of the report dealing with the direct process for the manufacture of sulphate of ammonia and the storage of ammoniacal liquor.

SULPHURIC ACID WORKS.

These works continued working under great pressure throughout the year. The urgent demand for sulphuric acid led in more than one case to unduly-prolonged delay in repairs, with a consequent continuation of conditions which could not be considered satisfactory.

The use of a mechanical washer for the recovery of nitrous gases from the residual gases leaving the last chamber was successfully introduced in one works, and is on the eve of introduction into others. This method of nitrous gas recovery presents some advantages. Large absorbing towers—especially if packed with coke—become after a few years' use impaired in efficiency, and, after prolonged use, become of very doubtful value. There is, however, frequently a hesitancy to incur the expense of re-packing, leading to inefficiency in "nitre" recovery and prejudicial effect on the working of the plant as a whole; so that intervention is at times useful in influencing the return to efficient productive conditions. This hesitancy approaches reluctance when large catch-towers dealing with the final gases from several sets of chambers are involved.

Some years ago, a similar development took place in Scottish blast-furnace works in connection with the recovery of ammonia. In these works, an excessively large volume of gas is produced per ton of coal used; the ammonia being present in very small proportion. To effect recovery, very large wash-towers were originally erected. Experience showed that the first cost was high, maintenance of efficiency was difficult, and re-packing a serious expense. Washers were then tried; and their fitness for the work led ultimately to a general replacement of tower by washer. The problem is similar in character in the chamber process; but as the volume of gas is very much smaller, the absorbing towers are much less in size. There are also other forms of packing than coke less open to criticism, which in many cases have given much satisfaction.

TAR-WORKS.

The number registered of this class of works was raised from 205 in 1914 to 248. This increase of 43 was chiefly associated with the extending practice of preparing useful products from crude tar produced in gas-works. The plant most frequently adopted in gas-works is of the dehydrator type, in which the tar undergoes a preliminary treatment for the production of a prepared tar suitable for use in maintaining road surfaces, and of light oils rich in benzol and toluol which are sent elsewhere for further treatment. A variety of plants have been erected for dehydrating, which are in successful operation. Some of them are intermittent, and some continuous, some are widely known, and some, in less frequent use, are capable of yielding equally suitable products; so that the employment of crude tar for road purposes, with its concomitant creation of local offence and loss of valuable volatile constituents, ought never to occur. Part of the increased number of tar-works was associated with the starting of new coke-oven works. These were not so numerous as those just mentioned; but the individual works were of much larger productive capacity, and the treatment of the tar was carried out more completely—a variety of volatile products and pitch being produced.

Operations were irregular in tar-works. In some districts of the country heavy stocks of pitch accumulated, owing to limited local demand, combined with difficulties of transit. In others, however, conditions were more favourable; a good influence being a better demand for patent fuel. These works were conducted satisfactorily. The means in use for preventing escape of the noxious gases evolved underwent no change, and continued to be effective.

In response to a request made by firms in the tar industry for some information regarding tar distilled and pitch produced, Mr. Curphey requested the District Inspectors to obtain the desired particulars from owners of the various works. This inquiry came at a time when owners had already received many official inquiries from other quarters, and when working staffs were depleted, so that in some few cases returns have been difficult to obtain. The following figures give the results arrived at for the United Kingdom, as near the truth as the absence of a small proportion of returns permits. This, of course, is a matter entirely at the option of owners; but hope is expressed that on another occasion complete returns will allow of accurate statistics being compiled.

Tar Distilled in the United Kingdom.

	Tons.
Gas-works	1,311,383
Other works	163,927

Pitch Produced in the United Kingdom.

	Tons.
Gas-works	669,489
Other works	80,907

Industrial Scientific Control.

In the concluding section of his report, Mr. Curphey says that during the year little or no change was observable as regards mutual effort to improve working methods, or as regards the fuller appreciation of the value of properly trained technical chemists; yet many instances arose in which individual manufacturers felt the want of proper guidance and advice. This experience was not confined to any particular manufacture. It is not to be expected, in the present state of opinion, that manufacturers will throw open their doors to competitors; but in the interests of all, wider views than those now frequent are desirable. Other means of co-operation in productive methods are, however, possible, more especially when co-operation in commercial methods is not a novelty.

In the Technical Press about a year ago, reference was made to the formation in France of a limited liability company with a given share capital and list of directors. Its objects were stated to be the manufacture and sale of sulphuric acid, and all scientific and technical researches, all industrial, commercial, and financial operations concerned with this object. Such a movement, if efficiently directed, would be of the greatest value to subscribers to a similar company in the United Kingdom, and would provide them with a channel of information regarding new proposals, along with means of obtaining reliable and skilled opinion.

Sulphuric acid manufacture is simply an illustration. In other branches of chemical manufacture similar or even greater opportunity occurs. There are numerous instances where individual firms are alive to progress, and keep themselves informed regarding developments. But in the interests of the industries as a whole, and therefore of the country, co-operative action with the objects indicated is worthy of consideration as a means towards general increased efficiency.

[An early opportunity will be taken of making reference to the reports of the District Inspectors; but it may be remarked that these appear on the present occasion in a considerably curtailed form.]

HEALTH OF MUNITION WORKERS.

The Question of Industrial Fatigue.

Some months ago, a series of memoranda were issued by the Health of Munition Workers Committee, who were appointed to consider and advise on various matters affecting the health and physical efficiency of employees in munition factories and workshops. Among them was one on hours of labour; and in this the Committee (the Chairman of which is Sir George Newman, M.D.) recommended that the average weekly hours of labour, including overtime, should not exceed 65 to 67 for men, and 60 for women. While suggesting that it might be desirable to differentiate to some extent between different kinds of work, no detailed information was offered, because at the time there were not sufficient data available to warrant any definite conclusions. Since then, however, special investigations have been undertaken with regard to output in relation to hours of labour at a number of munition works; and as some of the results obtained appear not only to afford information concerning the most suitable hours of labour in certain specific munition operations, but also to suggest some of the principles which should be followed in fixing the hours of labour for munition work in general, they have been issued as an appendix to the original memorandum.

The statistical information so published is set forth by Dr. H. M. Vernon, who in opening points out that the object of the Committee is really to ascertain the hours of employment most likely to produce a maximum output (without regard to cost of production) over months, or perhaps even years. In other words, of course, they wish to find the conditions under which workers will show greatest efficiency over a long period—*i.e.*, that will not lead to excessive fatigue or deterioration of health. Large and recently-built works were selected, where the conditions of labour—such as lighting, warming, ventilation, and the provision of canteens—were as favourable as possible. All classes of operatives were on piece-work, with no trade union restrictions whatever upon output; and they were paid at a high rate of wages. The types of labour investigated were very heavy, heavy, moderately heavy, light, and very light. For men engaged in certain very heavy labour, the maximum hours of actual work appeared to be 56 or less per week; for those doing heavy work, they were probably 60, or rather more; while for men and youths on light work, they were perhaps 70, or even more. On the other hand, for women engaged in moderately heavy labour, the maximum hours were 56 or less; while for those on light labour, they were rather over 60. In so far as time-keeping is a criterion, says Dr. Vernon, women and girls on very light work appeared to stand even 76 hours fairly well; but it is more than likely that their actual output was little (if any) greater than when they were working for 64 hours, and so it is probable that this figure should be regarded as their maximum.

The data furnished should prove useful to works managers; for though the fact is emphasized that the statistics are provisional, it is added that they clearly justify the conclusion that the hours of labour should be varied between wide limits according to the character of the work performed. The information given, it is said, also suggests that, not only are women unsuited to heavier types of work, but that even when engaged on the moderate and light types, they are unable to stand such long hours as the men. In connection with all the figures quoted, it has to be borne in mind that they are the maximum hours of actual work, supposing that the largest output is required regardless of cost of production. They relate, of course, to the fittest, who were strong enough to survive in the struggle, and not to the general mass of workers of all classes who tried their hand at munition work. Hence, says Dr. Vernon, the best hours of work suited for peace times are in every case considerably shorter than those mentioned, though the principle of graduating the number of hours of labour to the type of work performed still holds with undiminished force.

THE DREAM OF SIR WILLIAM RAMSAY.

The Sequel.

Shortly after the death of Sir William Ramsay, there was reference in these columns [*ante*, p. 209] to the suggestion once made by him in an after-luncheon speech regarding the sinking of boreholes into the earth, and the distilling of coal *in situ*. Almost immediately after the speech was made, it was announced in the newspapers that Sir William had been offered a seam of coal for the purpose of experiment. Then the whole matter seemed to drop into oblivion—nothing more being publicly heard of it. It appears, however, that steps were actually taken in the making of preparations for the experiment.

The sequel, so far as Sir William is concerned, was told by Sir Hugh Bell in the discussion on the Fuel Economy Committee's report at the recent meeting of the British Association; and in order that the sequel shall not be lost in the mass of reported words on that occasion, and that the tale may be rounded-off in our columns, special allusion may be made to the remarks of Sir Hugh Bell. It transpires that it was Sir Hugh himself who made the enterprising offer (it was accepted) of a seam of coal. This seam was eminently suited for such an experiment. It was a thin (partially worked) seam in Durham, overlaid by a thick bed of clay, with hardly any superadjacent rock, but a small quantity of shale upon the side of a hill, into which it was possible to get by means of an adit, and which could be attacked by a shaft. Nothing could have been better for the purpose Sir William had in view; and, under his direction, a considerable amount of money was spent in preparing an installation of plant for the purpose of the experiment. Sir Hugh was too modest to say in how large part he had been responsible for this outlay. However, the expenditure unfortunately appears to have been all in vain; for death put an end to Sir William's further participation in the experiment. Whether anyone else will be prepared to pursue it, cannot be said; but there is clearly the opportunity if anyone choses to avail himself of it. Sir Hugh Bell has his doubts whether anyone will care about it; for he remarked in a tentative sort of manner, which showed that no suggestion to continue the work had been made by anyone else, that, if there was another man as imaginative and daring as Sir William Ramsay, he would be pleased to place at his disposal the plant, and afford an opportunity for carrying on further experiments. No one appears to have jumped at the offer.

But Sir Hugh Bell has obviously come under the spell of Sir William Ramsay's "imagination and daring;" for he can see that, if such a scheme were practicable, it would enable the utilization of seams of coal that are at present abandoned for the more profitable ones. There is a great deal of colliery waste in this direction. "To be able," said Sir Hugh, "to consume *in situ* the thinner seams of coal which are at present unextractable, and which in all probability never could be extracted—seams of 2 to 3 inches in thickness—and bring the products of their carbonization to the surface in the form of a condensable gas and gases which would become liquids, would add very greatly to the prospects of those who desire to transmit energy from the colliery itself." It would depend on the cost of effecting the work as to whether it would add "very greatly to the prospects" to which Sir Hugh refers.

Money in Bye-Products.—According to the "Gas Record" [Chicago], the New England Manufacturing Company, in which the Massachusetts Gas Company have a half interest through ownership of 1000 shares, now produce about 5000 lbs. of picric acid daily. This is being delivered principally abroad, under contracts made with Foreign Governments a year ago, payment for which has already been made. With a continuance of the present production, the Company should be able in a few months to charge off from profits the entire cost of its plant in Woburn erected eighteen months ago. In addition to the profits of the New England Manufacturing Company, the Massachusetts Gas Company also receive a profit on explosives manufactured under a contract made by its subsidiary company, the New England Gas and Coke Company, to supply the New England Manufacturing Company with crude benzol from a new plant, with a daily capacity of 3000 gallons, built in Everitt a year and a half ago.

WATER ACTS FOR 1916.

THE changes effected in the gas measures promoted and passed this session have already been noticed; and now we may turn attention to alterations made in the water measures. The Bills were reviewed on Jan. 25, p. 202.

The Burnley Corporation have, by their new Act, been granted an extension of five years within which to complete the water-works—the Hurstwood reservoir among them—authorized by the Act of 1908. Provision has also been made for residential and hospital accommodation of the workmen engaged on the construction of the works. The proposals as to water-rents and borrowing powers are as when the Bill was under notice. [*Parliamentary Agents: Messrs. Lewin, Gregory, and Anderson.*]

The Conway and Colwyn Bay Joint Water Supply Board Act is the result of a late introduction; and therefore the provisions did not come under notice when dealing with the Bills in January. The cause of the late application has really to do with the war. In 1908, the Board received the sanction of Parliament to construct an embankment or dam across the outlet of Lake Cowlyd, and to use all the water they may from time to time require to comply with their statutory obligations. By the same Act, the Board were, for the protection of the Aluminium Corporation, Limited, placed under an obligation to discharge compensation water into the Afon Ddu, for the use of the Aluminium Corporation for their power and other requirements. By reason of the urgent demand for supplies of aluminium for, and in connection with, the manufacture of munitions of war, it is expedient that the Corporation should increase their output; and for this purpose they require additional water power. The only source from which this can be obtained is Lake Cowlyd and the Afon Ddu. With a view to providing it, an agreement has been entered into between the Board and the Corporation whereby the latter are *inter alia* to make a reservoir to be formed by enlarging and extending the lake by means of a dam across the Afon Ddu, and to take therefrom water for the purpose of power in lieu of the compensation water mentioned in the Act of 1908. The works of the Corporation are situate in the parish of Dolgarrog; and the Corporation's employees live chiefly in that parish and the Manager in the parish of Maenan. It is one of the terms of the agreement that the Board shall supply water in the parish of Dolgarrog and to the Manager's house; and for this purpose they have been allowed an extension of their district. The clauses of the Act give the Corporation, through the Board, all the necessary powers for the construction of a dam, 350 yards or thereabouts in length, with all the auxiliary works. The dam is to be completed to a height of not less than 30 feet within three years from the passing of the Act. Clauses appear relating to the taking of land, compulsory purchase (exercisable within one year), and rights of way over lands taken compulsorily. From the date of completion, the works and lands are to be transferred from the Corporation and vested in the Board, and are to be deemed part of their existing works and undertaking; but the dam is to be maintained by the Corporation to the satisfaction of the Board. In connection with the extension of the district, there is a provision that for the supply to the Manager's house in the parish of Maenan, the charge is to be for a period of 21 years 21s per annum, and after the expiration of that period the Board may demand and recover such rates and charges for the supply as may be agreed upon between the Board and the Corporation. There are a number of protecting clauses, but purely of local interest. [*Parliamentary Agents: Messrs. Bircham and Co.*]

The Tynemouth Corporation Act, which provides for an extension of the limits of the water supply area, so as to include the Ashington district, has been passed. The supply is to be given under the same terms and conditions, and at the same rates and charges for all purposes, as those existing for the time being for the like purposes within the borough, provided that the rates and charges made within the district shall not exceed the rates and charges authorized by the Act of 1897 and the Act of 1907. There is to be no dissimilarity of treatment in relation to supply between the consumers within the borough and those within the Ashington district, particularly in respect of domestic purposes. The Tynemouth Corporation are to purchase from the Ashington Council their mains, pipes, and meters, as they stand on the day of transfer, at a price equal to the then value, which, failing agreement, is to be determined by arbitration. Certain agreements made in 1894 and 1895, in which the Ashington Coal Company are concerned, are cancelled. Until Dec. 29, 1931, the Corporation are to be entitled to the exclusive use of the water plant and apparatus of the Company, subject to an annual rent of £150; but the Corporation may compound with the Company in respect of this annual payment. So long as the Corporation use the Company's plant, they are to repair and maintain it, and discharge all rates and taxes payable in respect thereof. It is also provided that the Corporation shall make or secure to the Company compensation in respect of the cesser of the right reserved to them to afford a supply of water through their plant to persons outside the district. Alternatively the Corporation may purchase the plant outright. The works proposed by the Bill are all authorized. There is a large batch of protective provisions in favour of local authorities, companies, and persons. In one set referring to the Northumberland County Council, it is enacted that the aqueducts laid in or along any main road shall, where reasonably practicable, be laid in such a position as the County Surveyor may in writing reasonably direct, and at a depth of not less than 2 ft. 6 in. from the top of the barrel of the aqueduct to the level of the surface of the macadamized portion of the road. The Corporation are also to make full compensation to the County Council for all damage and expenses reasonably incurred by the County Council in relation to the reinstatement of any roads, bridges, or other works from time to time by reason, or in consequence, of the leaking, bursting, or giving-way of any aqueduct or other work authorized by the Act. The financial powers detailed when noticing the Bill are all allowed; but the period asked for repayment in respect of the amounts required for the purchase of lands and easements and for the construction of works has been reduced from sixty to fifty years. [*Parliamentary Agents: Messrs. Torr, Durnford, and Co.*]

In the main features, the Act of the Wakefield City Council does not deviate from the Bill as reviewed in January last. The previously authorized reservoirs the construction of which it is proposed to abandon, the works it is now intended to construct, and the financial provisions are practically all as then stated; and so the particulars do not need repetition. Lord Saville has obtained the insertion of clauses providing for a new private roadway and for footways and footbridges as part of the works authorized; fishing, fowling, and sporting rights are protected; and other responsibilities are placed on the Corporation in the conservation of his Lordship's rights. Among subsequent clauses one is found putting upon the Corporation the obligation to see that the water supplied under the Act is properly and efficiently filtered or otherwise treated, so as to prevent it acting upon lead in such manner as to endanger the health of the consumers. There is to be a penalty not exceeding £10 for every day during which default shall continue. The clauses as to compensation water cover three pages of the Act. Fifteen years is the period within which the now authorized works are to be completed. The Corporation are empowered to take certain lands delineated on deposited plans, and described in a book of reference, provided that they shall enclose only as much of Rishworth Moor and Moss Moor as shall be required for the purposes of the undertaking. The Corporation may also hold any lands acquired by them under the powers of the Act which they may deem necessary for the protection of their water-works against pollution. There are a number of more or less ordinary provisions, which do not require special notice. [*Parliamentary Agents: Messrs. Sharpe, Pritchard, and Co.*]

The powers sought by the Yeadon Water-Works Company for the protection of their water supply have been granted; and the new land and works authorization, as set out in the Bill, has been allowed. But the new works are to be completed within seven years from the termination of the war, instead of ten years from the passing of the Act. The financial provisions are practically the same. In connection with the extension of the limits of supply, we do not see the contemplated power to purchase the undertaking of the Guiseley Water-Works Company. The period within which the Company are to furnish a sufficient supply of water to Hawksworth is reduced from seven years to five; otherwise the Rural District Council may make the necessary provision. The issue of redeemable preference and debenture stock is authorized. If so provided in the resolution sanctioning the issue of the stock, the Company may call in and pay off the shares or stock or any part thereof at any time before the fixed date of redemption. The shares or stock may be redeemed, either by paying them off or by issuing, subject to the consent of the holder, other shares or stock in substitution therefor. In this connection, the Company are allowed to set aside out of revenue after providing for the payment of interest on the mortgages, debenture stock, or preference capital, and other fixed charges or obligations, such sums as they may consider proper for the purpose of forming a fund for the redemption at maturity of any redeemable preference capital or debenture stock. The Company may invest any sums so set apart and the income therefrom in any securities in which trustees are for the time being by law authorized to invest trust funds, or in any other securities (not being securities of the Company, except as provided in the Act) in which they may be authorized to invest those sums by a resolution passed at a general meeting. In addition to the authorized rates for the supply of water for domestic purposes as provided by the Act of 1889, the Company may charge, in respect of every bath capable of containing when filled for use not more than 50 gallons, a sum not exceeding in the case of any house or part of a house of which the gross estimated rental is less than £20, 8s. per annum, and in all other cases 10s., and for every bath capable of containing when filled more than 50 gallons, such sum as the Company may think fit. The price to be charged for a supply by meter is not to exceed 1s. 6d. per 1000 gallons; but no person is to be entitled to a supply of water for any other than domestic purposes if such supply would interfere with the sufficiency of the supply of water for domestic purposes. There are also clauses designed for the prevention of plumbism; and it is enacted that all water is, if necessary, to be filtered for domestic purposes. Clauses for the protection of the West Riding of York Rivers Board, the Midland Railway Company, and the West Riding Asylums Board are included in the Act. [*Parliamentary Agents: Messrs. Rees and Freres.*]

The annual meeting of the Provincial Grand Lodge of Cheshire was held at Stalybridge last week, when Bro. Thornton Ousey, of Salford, was appointed Provincial Grand Steward.

NOTES ON BYE-PRODUCT COKING.

[COMMUNICATED.]

STOPPAGES IN PIPES (*continued*).

IN spite of all precautions, it occasionally happens that the gas-conducting main does become almost completely filled with a deposit of pitch. The writer has seen a collecting main, 18 inches in diameter, blocked for a length of several feet—leaving only space large enough for a rabbit to pass through. Trouble to this extent is, however, fortunately but rare; for long before this stage is reached, several warning signs should have been noticed. South Wales tars are particularly bad from the pitch trouble point of view. Tar from South Wales coal is notably deficient in light oils; and hence it has less viscosity than (say) a Durham tar. It contains a much higher proportion of pitch; so that it is much more likely to stick in the gas-main. The writer has met with coke-oven managers who are even opposed to the circulation of either tar or liquor in the main. The chief objection they have urged to tar circulation is that it causes a very considerable decrease in the benzol content of the gas. The tar acts as a scrubbing medium, and absorbs the benzol. The result is a decreased yield of the benzol plant; but at the same time the tar produced is correspondingly richer in light oil. There is, of course, a certain amount of truth in this argument; but there can be no question as to the foolishness of omitting circulation in the mains. The loss in benzol due to absorption by the tar is more than counterbalanced by the advantage of freedom from pitch troubles. It is not as if the tar was used to thoroughly wash the gas, as is done in the "C" process of benzol and toluol recovery. Temperature also plays a very important part in the matter of stoppages.

In the direct or hot-recovery processes, the tar is extracted from the hot gas—the temperature generally not falling below about 80° C. This means that much of the light oil passes forward with the gas, leaving a thick sluggish tar, which is very liable to cause stoppages, especially if through any unforeseen circumstances its temperature is reduced to about that of the atmosphere. This is most likely to happen if the plant has to be temporarily shut-down. In the hot process, therefore, one expects, and indeed generally finds, that the tar is deficient in light oils, but that a higher yield of benzol is obtained.

Should by any chance a main become seriously blocked, immediate steps must be taken to remove the stoppage. In the first place, care must be exercised to prevent the formation of any more pitch—especial attention being paid to the matter of hot ascension pipes. Some managers advocate the admission of steam into a blocked main; the argument being that this will soften the pitch, and cause it to flow. In the writer's opinion, this is wrong, for the following reason: The steam will have a temperature of about 150° C. only. At this temperature, the lighter constituents of the pitch, and also the naphthalene, are distilled; but the temperature is not high enough really to liquefy the pitch sufficiently to let it flow freely. The result is that a harder pitch is produced. A much more satisfactory method is to employ direct heating by means of a specially constructed fire bucket or cradle slung underneath the main. By this means, the pitch is well melted and thoroughly liquefied first at the point where it is in contact with the main. If the heating is commenced at the lowest point of the main, this (combined with continual poking and scraping through the inspection holes)will cause the deposit to move forward to the pitch-trap.

In plants where coolers are installed, blockages in the coolers themselves occasionally occur. Frequently, these are due to a too sudden cooling of the gas, and more often than not the deposit consists largely of naphthalene. In cases where the exhauster follows immediately after the coolers, a blockage between this point and the ovens is usually indicated by the action of the exhauster. It is customary to work the exhauster at such a speed as will allow of about 5 to 10 mm. pressure in the collecting main—giving the neutral point about at the inlet of the coolers. If a blockage is forming in the main, it is usually found that the speed of the exhauster has to be increased gradually, in order to maintain sufficient gas pressure in the latter portions of the bye-product plant. With the increase in speed of the exhauster, there is a corresponding increase of suction; and as the blockage gets worse, a still higher suction is shown on the board. Eventually such a state of affairs is reached that the blockage becomes complete, and the exhauster now having nothing to pull against stops. Immediately, the pressure on the ovens increases enormously and joints and doors begin to leak. The bye-pass valve on the gas collecting main must then be opened until the stoppage is located and removed.

Blockages due to naphthalene can usually be removed by allowing the cooler to become hot, by cutting off the water supply for a short time. This must not be unduly prolonged, as if it is the cooler becomes overheated and joints are likely to give on account of expansion.

With various forms of tar-extractors operating on the Pelouze and Audouin principle of wire-drawing the gas, it is not uncommon for the holes in the extractor plates to become blocked-up with thick tar, thereby causing the tar-extractor to throw an unduly high back-pressure. This is a very noticeable feature of the rotary tar-extractors, in which the gas has to pass through perforated revolving drums. The most usual cause of trouble here is the fact that the gas is cooled to too low a temperature before extracting the tar. The result is that the tar becomes very thick and viscous, and does not easily drip from the revolving drums. It is the practice on some works to introduce into the extractor steam with the gas; but this is not to be recommended. As already explained, steam distillation of the tar takes place with formation of pitch and its attendant troubles. It is much more satisfactory to raise the temperature of the incoming gas by slightly decreasing the water supply to the coolers. The extractor should be well flushed-out, and then filled with crude benzol. This will readily dissolve any tarry deposit, and will rapidly clean the drums.

One of the more frequent troubles connected with the heating of coke-ovens is the occurrence of deposits in the gas inlet pipes. These, being of small diameter and usually having many bends and angles, choke up very readily. Frequently the deposit is of an oily or tarry nature, and is due either to the inefficient extraction of the tar or else to creosote oil mechanically carried over from the benzol plant. There is also occasionally some naphthalene; but this should usually be extracted at the benzol plant. The remedy for such troubles is obviously to stop the cause by attending to the tar-extractors or else in baffle-plates to trap the creosote. Another deposit (and of a more serious nature) sometimes occurs here. If the ammonia is not thoroughly extracted, it tends to deposit in the form of ammonium carbonate, sulphide, &c., in the pipes in the form of a slime. Then, by the heat of the gas alley, it becomes hard and dry. When this occurs, the ammonia extraction is faulty and should be looked to.

WINDOW DRESSING AS AN AID TO SALES OF GAS APPLIANCES.

THE United Gas Improvement Company, of New York, in their house organ entitled "New Business," publish a well-reasoned and suggestive article on the value of the window display as a means of stimulating sales and of keeping stock moving. The word "window" is used in a wide sense, as including all kinds of show-cases, inside or outside.

A very general practice among retail storekeepers was to retain the services of a specialist as an expert window dresser, who was really a sort of housekeeper of the store, and responsible for preserving the whole in such order as would attract prospective purchasers—not only the windows, but also the whole of the displays and decorations throughout the building, including the exterior. He should know how, when, and where to exhibit any particular article, having in view the season of the year and the special requirements incidental thereto, and all National or local celebrations, anniversaries, &c., that are likely to influence trade. The work also included booths at fairs or exhibitions, floats for festive processions, and for special sales, such as the "Gas Lighting Week." On all special occasions, the window was the part of the store best adapted for conveying the desired message to the people passing along the street. The dressing should conform to, and be in sympathy with, the general scheme, and at the same time give appropriate prominence to any special concession offered as a means of attracting business, such as discounts or reduction of price over a limited period, free fitting, &c.

The window can be made to serve as one of the most powerful attractions for bringing in new business; and this form of advertisement should receive adequate consideration on the part of all heads or managers of sales departments. Even the most prosaic goods can be so placed or grouped as to tell a story that will appeal to human interest; and if a comprehensive design of this character is not practicable, the chief point is to see that the background and accessories are of an unobtrusive and simple, yet dignified, character. The leading article should be emphasized, and so arranged as to be a centre of attraction. Too many units or repetitions of the same thing are apt to create confusion, and divert attention from the central idea. Some very satisfactory results had been obtained by the show of a single article with appropriate surroundings, together with some neatly-lettered cards carrying brief descriptions, prices and terms, &c.

The design and selection of price or description cards have a most important effect on the value of the whole display. Stock patterns should be avoided; and it is worth while to pay a substantial price for a special design that would be recognizable as peculiar to the establishment. Detail in material and design, style and amount of lettering, border pattern, colouring, &c., should all be utilized in the creation of a distinctive character. The general opinion is in favour of a liberal use of price-cards, with the exception of expensive articles, the utility or desirability of which must be known before purchase would be seriously considered. A price figure of £25, with no other explanation, attached to a circulating boiler, might scare off the observer who had no idea as to the extent of comfort and convenience that such an appliance would bring into his home. With this class of apparatus, the show and description should be arranged with the object of inducing him to seek further information inside the shop; and the chances are that an interview with a competent salesman, including explanations of the merits, and perhaps easy terms of payment, will secure a sale.

A few illustrated examples are included. A gas-iron display was set out, with the aid of models, to emphasize the folly and

It did not need a

Paris Conference

to make the

Volker Lighting Corporation, Ltd.

support British Industries, and for the past Eight Years

VOLKER MANTLES

have been made by

British Labour

from the

Best British Thorium

and the

Best British Yarn.

Volker Mantles

**are British Throughout,
Always have been British,
and will be British when
the War is over.**

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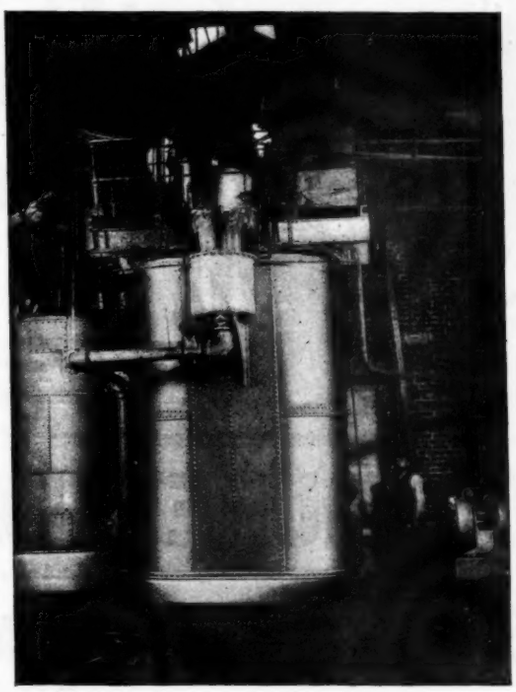

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impracticability of adhering to the discomfort and disadvantage incidental to old methods, when more and better work could be done, in a cool, clean, and comfortable way, by the use of a gas-heated iron. The message was directed to that trait of human nature that desires the best. Another example was a show of table lamps on the anniversary of Lincoln's birthday. A life-size bust, on an appropriate pedestal, was the centre feature; and it was surrounded by an attractive show of lamps, supported at different heights, with the original and the sale price of each clearly shown, and large placards told the story of the sale and the concessions of prices that were offered. The floor of the window was covered with green felt, bordered round the sides, and the background was a richly panelled partition. Another window, on the same occasion, was fitted with a revolving platform, carrying five lighted lamps, as the centre feature. Curiosity as to the means by which the supply of gas was conveyed to the moving lamps proved a great attraction, although the matter was easily managed with the aid of ball-and-socket joints. The floor was covered with dark green flannel; and the background was dark oak, panelled with four strips of brown velvet. A board covered with blue velours was placed on each panel; and each board carried four gas-brackets complete with glass, &c. A group of portable lamps was arranged round the centre revolving light.

THE SELECTION OF EMPLOYEES.

Writing in "Engineering News" [New York], Mr. C. E. Bock offers some pertinent remarks on the methods usually adopted in the selection of employees, as suggested by the examination of some 3000 applications received from engineers and technical graduates, in respect to form, diction, spelling, pronounciation, general arrangement, clearness, &c. In the applications from college graduates, common faults are defective spelling, careless handwriting, lack of definition, poor composition, and a generally slovenly appearance. A young and inexperienced writer cannot be expected to turn out a faultless composition; but if he possesses any potential ability, he will not exhibit gross carelessness in a letter seeking employment, as such habits are particularly disqualifying for engineering work, and will not be tolerated by competent engineers. According to Mr. Bock, replies sent in response to advertised vacancies are very similar, in the United States, to those received in this country.

An advertisement of a vacancy involving cousiderable responsibility in the handling of affairs and the control of men, resulted in the receipt of 209 replies, of which no less than 50 per cent. stood no possible chance of success, by reason of the omission of essential details. Among other particulars requested were references and salary expected; and only 77 applicants supplied the first, and 13 the second. Only 40 gave any indication of character and habits, 104 stated years of experience, 133 their training and education, and 112 their age. And this for an important position, as shown by the fact that the average of the ages stated was 35, the average experience 12½ years, and the average salary expected, $280 per month.

In reviewing the position as above indicated, "Gas Age" suggests that inability to appreciate the employer's point of view on the part of the applicant is the cause of a large proportion of unsatisfactory applications. The writer should remember that the employer's time is more in demand than his own, and aim at furnishing a communication which, like all other properly-drafted business letters, should be complete in itself, and not require further development or explanation by subsequent correspondence. If the letter is a proposition, it should contain all the information required to enable the recipient to say "yes" or "no." The same remark applies to the needs of the employer, which should be fully expressed, in order to give applicants all necessary information.

Employees taken on trial are very expensive; and it pays to select the right man in the first place, rather than try out a number, until the suitable man is found. If the written application in itself condemned half the men who supposed themselves fitted for the work, it also gave a fair indication of the chances which the trial system offered for the securing of competent men, and general experience bore out the need for careful attention in the selection of the staff. It was better to develop and show practical appreciation for the material already to hand, in the form of tried employees, than to be constantly seeking for new ones, in a bargain hunting spirit.

The subject of methods concerned in the selection of suitable employees is one that especially concerns employers in this country at the present time. With that return to normal conditions, which we are all beginning to hope is coming in sight, there will be the question of bringing up the depleted staff to permanent strength, and of filling the vacancies left by the hundreds of thousands who have fallen in the service of their country, which include many of our most promising and valuable men. There may be an actual scarcity of the right material in respect to certain lines that require special experience and training. Taxes and prices of materials cannot be expected to return to normal levels for some time, and things in general will need to be run on a margin of economy that was not found to be necessary before the war. So there is excellent reason for considering any means of bringing the technical and commercial staff in any manufacturing industry up to a degree that will be adequate to the new conditions.

THERMAL PROBLEMS FOR GAS ENGINEERS.

X.

By Norton H. Humphrys, Assoc.M.Inst.C.E., F.C.S.

Carburetted Water Gas.

Having noted some of the properties peculiar to blue water gas, oil gas, and coke, we are now in a position to approach the subject of carburetted water gas, which consists of a mixture of blue water gas and oil gas, in the proportion of 4 or 5 to 1. The oil gas is not prepared by destructive distillation in a retort, and therefore differs in some respects from the article usually understood by that title. It is produced by injection into a generator, in comparatively small quantities, at a temperature lower than the 1700° Fahr. mentioned in the paper on the Peebles process to which reference has been made, immediately mixed with its quantum of blue gas, and exposed to a considerable degree of contact with heated chequer brick in the generator and superheater.

The result of the dilution and of the large extent of heated surface, is a secondary action on the products of distillation, of a different nature to that which obtains in an otherwise empty retort. The heavy hydrocarbons peculiar to oil gas are to a large extent broken-up into simpler and lighter compounds, such as methane, attended with the formation of ethylene, benzene, and other substances that are not present as such in the original material; but the temperature is not high enough to form any appreciable quantity of hydrogen. The heat required for this work is provided by that coming off from the cupola during the blow, and would otherwise go to waste; so the heat absorption in the generator is not a matter of much practical consequence. The best result obtainable per gallon of oil used, however, is an important consideration, at the present price of oil. When we remember that the Peebles process, while giving better results both as to quality and quantity of gas, at the same time furnishes over 30 per cent. of high quality, 98 per cent. pure coke, also the 10 to 20 per cent. of tar and oily residues that are always a feature of the carburetted water-gas process, it is evident that there is some room for improvement.

Economy Secured by Preliminary Heating of the Incoming Oil.

We have observed that the gases escaping from the cupola carry away a large quantity of heat—no less than 993 B.Th.U. per pound weight—and that a part of this heat is turned to account in the generator and superheater, for the decomposition and gasification of the oil. But at the outlet of the superheater, the gas retains a temperature of 1000° to 1200° Fahr.; hence the advantage of using an oil-heater, by means of which a part of this heat is passed on to the incoming oil.

On a make of 150,000 cubic feet of gas, the weight of which would be not less than 6500 lbs., the heat carried away at the superheater outlet would be $1200 \times 0{\cdot}46 \times 6500 = 3{,}588{,}000$ B.Th.U. The oil consumed in the production of this quantity of gas may be taken as 300 gallons, or 2550 lbs. weight; the specific heat as 0·4; and the heat required to raise it 1° Fahr. in temperature is $2550 \times 0{\cdot}4 = 1020$ B.Th.U. The heat necessary to bring it up to 1200° is $1020 \times (1200 - 60) = 1{,}162{,}800$ B.Th.U. = not one-half the quantity that is carried off by the gases—and there should be no practical difficulty in effecting a substantial saving of heat by means of a preliminary heating of the oil. The heat so carried into the generator, like that conveyed to a furnace by the use of regenerators for heating the incoming air supply, is not only helpful as economizing heat, but also as aiding in the maintainance of a proper working temperature.

A Theoretical Mixture of Peebles Oil Gas and Blue Water Gas.

We have seen that, by means of the Peebles process, a gas having an enriching value of 90 candles can be obtained, and now propose to examine the composition and properties of a mixture of Peebles gas with blue gas, in such proportion as to furnish a gas suitable for use on ordinary gas-works. This may be based on a consumption of 2 gallons of oil per 1000 cubic feet of gas made, which means 17 parts of oil gas to 83 parts of blue gas. The illuminating power of such a mixture would be $\frac{17 \times 90}{100} = 15{\cdot}3$ candles, equivalent to 7·65 candles per gallon of oil. The specific gravity would be $\frac{(0{\cdot}880 \times 17) + (0{\cdot}52 \times 83)}{100} = 0{\cdot}5812$. The weight of one cubic foot $\frac{(0{\cdot}068 \times 17) + (0{\cdot}3995 \times 83)}{100} = 0{\cdot}04471$ lb., and the bulk of 1 lb. weight, 22·4 cubic feet. The calorific value should be $\frac{(1488 \times 17) + (339 \times 83)}{100} = 534$ B.Th.U. The composition of the gas, in terms of bulk or volume, would be:

Oil gas	hydrogen . . .	16·85 × 17	..	286·45	
,,	methane . . .	19·00 ,,	..	323·00	
,,	ethane	17·30 ,,	..	294·10	
,,	hydrocarbons. .	44·83 ,,	..	762·11	
,,	incombustibles .	2·02 ,,	..	34·34	.. 170,000
Blue gas	hydrogen . . .	51·2 × 83	..	4,249·60	
,,	carbon monoxide	46·4 ,,	..	3,851·20	
,,	,, dioxide .	2·4 ,,	..	199·20	.. 830,000
				1,000,000	.. 1,000,000

This may be simplified into percentage by volume in the mixed gas:

Hydrogen	45·36
Methane	3·23
Ethane	2·94
Hydrocarbons	7·62
Carbon monoxide	38·51
,, dioxide	2·34
	100·00

To get the composition of the mixture in terms of weight, the respective components must be multiplied by their various proportions—viz., the oil gas by 17, and the blue gas by 83.

	Oil Gas × 17.		Blue Gas × 83.		Total.
Hydrogen	0·0894	+	0·2714 ÷ 10,000	..	0·002404
Methane	0·8147	..	—	..	0·001385
Ethane	1·3780	..	—	..	0·002343
Hydrocarbons	4·3143	..	—	..	0·007937
Carbon monoxide	—	..	3·4421	..	0·028568
Incombustibles	0·1836	+	0·2817	..	0·002004
Weight per cubic foot					0·044641

From the total in the fourth column, the calorific value can be calculated:

Hydrogen	0·002404 × 61,885	..	148·7772
Methane	0·001385 × 24,169	..	33·4741
Ethane	0·002343 × 22,351	..	52·3684
Hydrocarbons	0·007937 × 21,469	..	170·3994
Carbon monoxide	0·028568 × 4,421	..	126·3080
Incombustibles	0·002004 —	..	—
	0·044641		531·3271

Comparison with Results Obtained in Ordinary Working.

These estimated figures will now be compared with actual everyday working. Running an old-fashioned plant of 150,000 cubic feet per twenty-four hours nominal capacity, the average of 34 weekly analyses in percentage by volume, was

Hydrogen	37·89
Methane	16 18
Hydrocarbons by bromine	7·67
Carbon monoxide	30·08
Incombustibles	8·18
	100·00

The calculated calorific value, reckoning the hydrocarbons as ethylene, is 516; the observed value by the calorimeter, 537; and the calculated value by Coste's formula, 568 B.Th.U. per cubic foot. The consumption of oil averaged 2¼ gallons per 1000 cubic feet of gas, and the illuminating power, 15 candles—being at the rate of 6⅔ candles per gallon of oil. The calculated specific gravity, taking the bromine absorbtion as ethylene, is ·568; but the observed specific gravity was always ·03 to ·035 in excess. This being taken as the correct indication, the presence of hydrocarbons other than those taken up by bromine is suggested, and, incidently, the unreliability of that re-agent as a means of detecting the percentage of illuminating hydrocarbons in a gas. A similar difference is observable with samples of coal gas. The calculated specific gravity corresponds to a weight of 0·0436 lb. per cubic foot, and 22·93 cubic feet to the pound. But the observed value indicates 0·0461 lb. per cubic foot and 21·7 cubic feet to the pound.

In Messrs. Humphreys and Glasgow's pamphlet No. 7 will be found the following analyses of crude carburetted water gas:

	Page 61.		Page 65.
Hydrogen	32·2	..	28·7
Methane	16·5	..	20·7
Hydrocarbons	10·5	..	11·8
Carbon monoxide	32·8	..	30·1
Incombustibles	8·0	..	8·7
	100·0	..	100·0

Taking the second test, the figures, which indicate the percentage by volume, correspond to—

	Weight in Lbs.		Calorific Value.
Hydrogen	0·1521	..	93·0131
Methane	0·8876	..	219·1484
Hydrocarbons	1·1303	..	243·0145
Carbon monoxide	2·2300	..	104·4609
Incombustibles	0·7910	..	..
	5·1910	..	659·6369
Per cubic foot	0·0519	..	660 B.Th.U.

Specific gravity (calculated) ·674; cubic feet to the pound, 19·3.

The illuminating power of the gas is evidently greater than the previous samples, and is stated to be considerably over 20 candles. The methane and hydrocarbons may be assumed to be furnished by the decomposition of the oil; but there is reason for believing that quite an appreciable amount of the methane comes from the cupola. If a sample of thoroughly dried coke is tested for volatile matter, in the same way as it is usual to test coal, a small percentage is invariably found to be present. This qualification does not apply to the Peebles mixture, in which it will be found that the hydrocarbons account for 0·116 lb. per cubic foot; leaving 0·0331 lb. to be provided by the cupola. In the practical example, the corresponding figures are 0·0186 and 0·0274, and in that of Humphreys and Glasgow 0·0204 and 0·0315.

The figure for the Peebles mixture agrees with the weight of the gas after allowing for the incombustibles. That for the practical example is too high, as the total weight of the oil used (2¼ gallons at ·85 specific gravity) would be 191 lbs. Allowing 15 per cent. for the tarry residues, the weight left in the gas would be 0·0162—leaving 0·0024 lb. of methane to come from the cupola. Making a corresponding correction on the Humphreys and Glasgow figures, we arrive at 0·0174 lb. for the oil, 0·0345 lb. for the cupola. Adding 15 per cent. for the tar, the consumption of oil would be 2·8 gallons per 1000 cubic feet.

In the Peebles mixture, the 534 B.Th.U. comprises 253 from the oil and 281 from the cupola. The figures for the practical example are 263 and 275, and for the Humphreys and Glasgow, 462 and 197. Taking the calorific value of the oil as being 20,000 B.Th.U. per gallon, the percentage of the same that is present in the gas is—

Peebles	256	out of 340, 75	per cent.
Practical	263	,, 382, 69	,,
Humphreys and Glasgow	462	,, 472, 97	,,

The last two are subject to correction, on account of the part of the methane that comes from the cupola.

By the courtesy of Mr. W. B. Mimmack, the Engineer and Manager of the Pembroke Docks and Town Gas Company, I have been furnished with the details given in Table IX, which have been compiled by the Assistant Gas Manager and Chemist, Mr. S. J. B. Tully. It includes the results shown by twenty-four analyses of crude carburetted water gas, as manufactured in a

Table IX.—*Composition of Crude Carburetted Water Gas.*

Date.	Oil Used per 1000 Cubic Feet.	CO_2	O	C_nH_n	CO	CH_4	H	N	Specific Gravity Estimated.	B.T.U. Estimated.
1915.										
Dec. 3	2·56	3·7	0·3	8·6	33·6	10·27	38·68	4·85	·5981	479·60
,, 9	2·13	3·4	0·2	10·0	33·4	14·8	32·96	5 24		529·19
,, 13	2·33	3·39	0·0	8·38	34·13	14·97	32·70	5·43		506·51
,, 14	2·13	3·1	0·2	5·2	33·9	13·95	33·18	10 47		454·89
,, 16	2·19	3·3	0·2	8·2	34·0	14·28	34·82	5·20		503·02
,, 21	2·64	3·1	0 1	5 5	38·2	10·54	37·88	4·68		445·25
1916.										
Jan. 10	2·33	4·5	0·1	10·4	30·6	14·61	31·08	8·71		458·30
,, 12	2·11	4·8	0·2	10·0	29·6	14·72	33·87	6 81		518 78
,, 28	1·54	5·6	0·2	6·4	32·8	11·51	36·64	6·85		447·64
,, 29	1·59	4·5	0·0	6·5	34·8	11·61	39·72	2·87		467·00
Feb. 10	1·55	4·4	0·2	7·0	33·4	11·63	38·39	4·98		466·28
,, 11	1·66	4·7	0·2	8·3	33·2	11·57	36·91	5·12		481·02
March 15	1·47	4·4	0·2	6·4	33·0	10·18	38·75	7·07		441·66
,, 23	1·47	4·0	0·2	3·8	35·8	7·07	45·29	3·84		398·63
,, 25	1·47	3·4	0·0	4·2	36·2	13·3	37·41	5 49		444·55
,, 28	1·75	4·6	0·2	4·6	35·4	11·6	38·48	5·12		434·38
,, 29	1·78	4·6	0·2	7·0	33·6	10·4	38·09	6·11	·6077	453·37
,, 30	1·78	4·8	0·2	4·8	35·2	8·68	42·40	3·92		419 78
,, 31	1·78	5·0	0·0	5·0	35·2	9·59	42·73	2·48		433·38
April 1	1·78	4·8	0·0	4·6	35·2	11·93	38·78	4·69		438·08
,, 3	1·80	4·4	0·2	6·2	34·8	10·0	42·94	1 44		456·3
,, 18	1·80	4·4	0·2	4·6	34·0	10·79	44·37	1·64	·5486	440·41
,, 19	1·80	4·6	0·2	4·2	33·6	9·63	42·79	4·98	·5687	415·87
May 23	1·86	4·6	0·4	7·6	33·2	10·65	39·41	4·14	·6034	468·51
24)	45·30	102·09	0·39	157·48	816·83	278·28	918 27	122·23	5) 29265	10,902·30
Averages	1·88	4·25	0·16	6·55	34·00	11·59	38·26	5·09	·5853	454·26

new set of apparatus, embodying the latest improvements, recently erected at the gas-works at Pembroke Dock by Messrs. Humphreys and Glasgow. From the averages, the parts by weight, and the calorific value, taking the hydrocarbons as ethane, are calculated. In the table they are most probably reckoned as ethylene.

The analyses show an excess of hydrogen over carbon monoxide from which it is probable that the generator and superheater are worked at a temperature sufficient to produce some quantity of hydrogen from the oil, and this may be taken as offsetting any methane produced in the cupola. On this basis, the oil furnishes 238 and the blue gas 244 out of the total of 482 B.Th.U. per cubic foot of the gas.

The consumption of oil is $1{\cdot}88 \times 8{\cdot}5 = 16$ lbs. of oil per 1000 cubic feet of gas, which at 20,000 B.Th.U. per pound represents 320,000 or 320 per cubic foot. Of this, 238 B.Th.U. or 74½ per cent., is passed on to the gas.

	Parts by Volume.		Parts by Weight.		Calorific Value.
Hydrogen	38·26	..	0·2027	..	12544·1
Methane	11 59	..	0 4970	..	12003·9
Hydrocarbons	6 55	..	0·5219	..	11665·0
Carbon monoxide	34·00	..	2·5260	..	11854·7
Incumbustibles	9·60	..	0 8000	..	..
	100·0	..	4·5476	..	48067·7
Per cubic foot			0·0542 lb.	..	481B.Th.U.

Specific gravity, ·585; 22 cubic feet to the pound. Weight of one cubic foot, 0·0457.

In addition to the loss of calorific value by liquid condensation, the secondary decomposition is always attended with deposition of carbon on the chequer work, which is burnt off during the following blow.

(To be continued.)

SIXTY YEARS AGO.

From the "Journal" for September, 1856.

Disadvantages of Unlimited Competition.—The report of the last half-yearly meeting of the Phœnix Gas Company will be read with unalloyed satisfaction by all who are interested in the success of gas companies generally, and may also be studied with profit by those who have hitherto advocated unlimited competition as the best protection for the gas consuming public. Experience has again demonstrated that such a system not only entails the payment of interest upon a larger capital than would otherwise have been required for the construction of works, but also materially enhances the cost of distribution; both of which expenses must ultimately fall upon the public, and retard reductions in the price of gas, which, but for these impolitic proceedings, might have been made without compromising the interests of those who had invested their capital in these undertakings. This is so clearly and indisputably set forth in the issue of the contest between the four Companies recently competing for the supply of gas in the districts south of the Thames, that a brief sketch of their proceedings will be read with interest at the present moment. The Phœnix Gas Company was formed in 1824. At later periods, its territory was successively invaded by the South Metropolitan, the London, the Deptford, and the Surrey Consumers' Companies. An active competition was carried on between the various bodies for several years, till the Phœnix retired from the Deptford district, and in January, 1854, the other four Companies came to an arrangement for an equitable division of the district; and subsequently the Deptford became merged in the Surrey Consumers' undertaking. The effect of this arrangement upon the Phœnix Company has been to reduce their gas leakage from 31 to 14¾ per cent., and to increase the revenue from 29s. 3½d. to 35s. 3¾d. per ton of coal carbonized, without any alteration in the price of gas. In the half year ending Midsummer, 1855, the coals carbonized were 33,437 tons, to produce a gas-rental of £48,983; whereas 30,524 tons of coal yielded a gas-rental of £53,901 during the last half year, and the saving in coals, combined with their increased produce, has added about £14,000 to the net yearly profit. Comment upon such results is unnecessary.

A Portable Gas Company.—A prospectus has been issued, under respectable patronage, for the formation of a company, under the title of the British Portable Gas Company, for the purpose of introducing and bringing into use a new improved gas apparatus. The material from which it is proposed to manufacture gas is stated to be a resinous oil, the cost of which at the principal ports of the kingdom is calculated to be 9d. per gallon. But as the estimated cost of the gas, with a manufacture of 700,000 cubic feet per annum, after deducting nearly two-thirds of the first expense of the oil for the value of the residual products, is 7s. 6d. per 1000 cubic feet, without any allowance for leakage or the expenses of distribution, it is evident the system can never come into competition with coal gas.

Threatened Curtailment in the Supply of Gas Oil.—Under the auspices of the Institution of Gas Engineers, a meeting is to be held at half-past eleven next Monday, at the Westminster Palace Hotel, to consider the letter issued by the Director of Munitiont Overseas Transport with reference to the threatened curtailmens in the supply of gas oil.

LARGE SURFACE-COMBUSTION GAS INSTALLATION IN AMERICA.

The Eddystone Ammunition Company, of Eddystone, Pa., have recently laid down a large installation of gas-fired furnaces, adapted for hardening and tempering 3-inch steel shells, comprising three sets, each set working as a distinct unit, and consisting of a hardening and a tempering furnace. The outside dimensions of each furnace are 22 ft. long, 8 ft. wide, 7 ft. high. After full investigation, it was anticipated that a 580 B.Th.U. gas, at approximately 43 c. per 1000 cubic feet on a sliding-scale basis, would really be cheaper than fuel oil at 4½ c. per gallon, besides giving greater facilities for regulation and control. The two units already in operation prove fully equal to all expectations. The furnaces are fired by the surface-combustion high-pressure system, in which the high-pressure gas is made to inspirate the air necessary for complete combustion, and automatically maintain a constant proportion in the mixture, without the aid of motors, blowers, and a run of air-piping. It is a one-pipe system that can be controlled from a centre platform by one operator; each furnace being governed by a single pressure regulating valve. The pressure ranges from 5 to 25 lbs. per square inch, the average being 15 lbs. Indicating and recording pyrometers are provided, together with full time and temperature instructions, to be closely followed by the central attendant. There is also an electric signalling apparatus, by which a red light is shown at intervals of two minutes, as a signal for the operation of the shell pusher.

The gas is supplied by the Philadelphia Suburban Gas and Electric Company, of Chester, Pa. It is delivered and metered under a pressure of 25 lbs. per square inch; a rotary pressure meter and a Bailey flow meter being used. Each unit consumes an average of 3300 cubic feet of gas per hour, and turns out 240 shells in that time. When the three sets are working full power 20 hours per day, the consumption will be 237,000 cubic feet of gas per day, and, on a basis of 300 working days, will exceed 70,000,000 cubic feet a year. The output will be nearly 15,000 shells per day, and the consumption of gas per shell, 15·8 cubic feet.

The hardening temperature is about 1500° Fahr., and the tempering, 1100°; and approximately one hour is occupied by the passage of one shell through each furnace. The shells are 3 inches diameter, 8½ inches long, and 8 to 11 lbs. in weight. The furnace working efficiency averages 32 per cent. Eight steel angles extend from end to end of each furnace, and act as troughs for the conveyance of the shells. An air cylinder, with an arm attached to a piston rod, acts as a pusher, and the shells are fed-in by hand. Every two minutes the pusher moves forward the length of one shell—thus discharging a row of eight into an oil-quenching bath situated at the discharging end of the furnace, from which they are conveyed to the tempering furnace, when sufficiently cool, by means of a bucket elevator and conveyor, where they receive a similar course of treatment.

The furnaces are mounted on concrete foundations, and enclosed in cast-iron cases with strong tie-rods. The heavy firebrick linings are backed with sil-o-cel, which affords ample insulation, and cuts down the radiation losses, as well as protecting the workmen from the effects of the heat. They are as near airtight as possible; and as a further precaution agrinst the cooling and oxidizing effects of leakage of cold air, a slight pressure is maintained in the furnace, which is designed to ulilize a maximum of radiant heat. The flues uniformly distribute the hot gases, and release them at the lowest practicable temperature. Each hardening furnace is heated by 22 high-pressure burners, and each tempering furnace by 18. Each burner is fed by a ½-inch branch from a 1-inch stem, and all piping is laid below ground level, in conduits fitted with removable covers, so as to avoid overhead or exposed piping.

Analyses of the outlet flue gases prove absence of oxygen or carbon monoxide, and 15·2 per cent. of carbon dioxide. This absence of excess of air and of unburned gases indicates a combustion efficiency equal to 100 per cent.

The initial cost of the gas-fired equipment complete was quite 30 per cent. less than that of the oil-fired installation previously in use for some time, and which had been carefully tested under working conditions. The reason of this was the absence of several accessories required when oil was used—such as storage tanks, pumps, oil, steam, and air-pipe lines, and electrical fittings. Other advantages were: No necessity for running a stock of fuel; no fluctuations in the market rates or uncertainty as to delivery; constant composition and calorific value of the fuel; full and easier control; uniform production; saving of labour, &c.

The installation was designed and erected by the Surface Combustion Company, of New York City.

The Northampton Polytechnic Institute, St. John Street, London, E.C., forward a copy of their educational and social announcements for the forthcoming session. These include, among many other subjects, day and evening courses in civil, mechanical, and electrical engineering. Owing to the influence of the war on the probable attendances of students, it has been found necessary to stipulate that the starting of any particular class shall depend on the number of applications received for enrolment early in the session. Those intending to join, should therefore communicate promptly with the Principal, Dr. R. Mullineux Walmsley.

TESTS OF STREET ILLUMINATION.

During recent years a good deal of time has been spent in the endeavour to find a method of adequately appraising street illumination in the interests of the public and with fairness to the systems of lighting adopted. A number of the proposed tests have met with acceptance, but none with universal approval. To the list has now been added a method which Mr. Preston S. Millar has placed on record in a contribution to the proceedings of the Philadelphia Section of the American Illuminating Engineering Society, and published in the recently issued June number of their "Transactions." The paper is of interest, and gives full particulars of the method adopted by the author and his colleagues, with the conclusions deduced by them as to the general end which investigators and testing methods should have in view.

Mr. Millar states that the application of all measures of street illumination has been complicated in the past in that the intent has been to make them serve both as measures of illuminating effectiveness and as means of proving fulfilment of contractual obligations—these being considered by the 1913 Committee on Street Lighting of the National (U.S.A.) Electric Light Association as "two separate and distinct problems." Separate tests of these, he remarks, would clear the situation and promote proper consideration of these and other proposed measures. The test adopted to prove satisfaction of a contract may or may not indicate the effectiveness of the street lighting; and determinations of the latter should precede the letting of the contract, and should be applied to the selection of the best equipment as well as the form of installation.

The measurement of the effectiveness of street lighting is the subject to which Mr. Millar devotes himself in the paper. A few paragraphs, however, are first contributed on the question of the fulfilment of contractual obligations. The author gives it as his opinion that, where possible, the contract should specify and describe the lamps, equipment, and operating practice. The latter does not necessarily mean photometric tests. Nevertheless, these are sometimes required, and often involve considerable difficulties. It is somewhat surprising to read the author's unqualified statement that "the one basis of test which has the endorsement of engineering societies and electric light associations is the measurement of the total flux of light." It may be noted, however, that the paper is concerned with electric lamps; and the data derived are from this source of illumination alone. The statement may be qualified with this in mind. The mean hemispherical values of electric arc lamps—not by any means infrequently used for rating purposes—are not mentioned.

The use of an integrating sphere photometer, both in the street and the laboratory, is regarded as applicable and affording a generally satisfactory method of testing. The test in the street involved the lowering of the lamps into the sphere; photometric values being obtained throughout one feeding interval of 7 to 15 minutes. Two lamps per hour were measured. Where lamps were rigidly mounted upon high poles, it would be necessary to assemble some on temporary supports for more convenient testing, or, it may be, to take them to a laboratory. The purpose of the paper, however, was not to discuss tests used from a contractual point of view, but rather to deal with investigations of the effectiveness of street illumination. And it is in this phase of the subject that lies the chief interest of the contribution. It is stated that three factors in combination—glare, the silhouette effect, and the influence of specular pavements—have so much weight that intensity of light incident upon observed objects could no longer be regarded as an adequate criterion of illuminating value. Mr. Millar's work in the streets brought him to the conclusion that the deleterious effect of glare in actual lighting was much less marked than laboratory results indicated. He also realized the importance of the silhouette effect, and also of the influence of the specular qualities of street pavements, neither of which, he says, had previously entered into engineering calculations of the street lighting problem.

As, in the author's opinion, measures dealing with intensity of light do not provide a comprehensive and reliable test of the effectiveness of street illumination, it had become necessary to develop a new system of consideration of the problem. In studying the latter, from what Mr. Millar calls the "new view point," the fundamental principles of street illumination are stated as follows: For any given cost, street illumination should possess the highest possible effectiveness. The latter is measured by the extent to which the lighting system fulfils its functions; and these are, first, to reveal, and, then, to please. There could be no gainsaying the basic proposition that the revealing and pleasing qualities of street illumination (having regard to the class of street) determined the effectiveness, and that the latter could only be tested by measuring these factors. The relative pleasing qualities of two systems are matters of judgment and taste, not susceptible of definite determination; but this phase of evaluation is not discussed in the paper. On the other hand, the relative revealing qualities of the two systems of lighting may be measured with approximate accuracy, and could be used as measures of the effectiveness of illumination in streets where the lighting expenditure was so low that the revealing factor was the only criterion. The principal requirements of street lighting may be said inclusively to cover the revelation of large objects on the street and irregularities on the street surface. Unless lighting systems can be rated with regard to these requirements, the author considers we are without means of definitely evaluating street illumination.

Reference is made to the conclusions derived from investigations made of street lighting systems which were installed by the New York Edison Company. The general results were embodied in the 1914 and 1915 reports of the Street Lighting Committees of the National Electric Light Association and the Association of Edison Illuminating Companies. The conclusions notably were "that uniformity of illumination intensity is not necessarily desirable in street lighting; that, other things being equal, the illumination from a few large lamps is likely to be superior for street lighting to illumination from many small lamps; and that a very considerable change may be made in intensity of light without influencing the effectiveness of the illumination so largely as does an improvement in the location or equipment of the lamps." The methods of investigation originally proposed for Mr. Millar's method were found unsuitable, but were developed until a high state of effectiveness was attained, and it was then felt that the scheme as a whole provided an excellent means of judging the relative revealing qualities of systems of street illumination. Whether this view is justified is perhaps a matter of opinion; but the general expense and cumbersomeness of the method with which the author has associated himself must make it impracticable. The testing system tried at New York, and substantially adopted in the Philadelphia investigation, will be best judged by the following particulars which in the paper are treated in full detail by Mr. Millar.

A level and straight street, approximately a mile long and reasonably free from traffic, was found in Cottman Street, Philadelphia. In most of the tests twelve lamps were installed on poles with light centres 22 feet high and spaced approximately 210 feet apart. Two systems of electric lighting were investigated—viz., 4 ampere magnetite lamps run from a rectifier equipment, and carbon open arc lamps operated on a standard 9·6 ampere direct-current series street lighting circuit. Photometrical measurements were made (*a*) of the total light flux—the lamps being lowered into a 40-inch integrating sphere mounted on a truck; (*b*) of the horizontal illumination just over the street surface; (*c*) of the vertical illumination 4 feet above the ground level; and (*d*) in some cases of the brightness of the street asphalt surface. Tests of direct illumination—that is, with the screen at right angles to the line of direction—do not appear to have been undertaken.

The investigation of the "revealing qualities" of the illumination was novel, and forms the chief feature of the paper. This was of two kinds—viz., observations by pedestrians upon small 2¾ inches in diameter sheet iron disc targets laid on the street surface, and observations by automobilists upon larger vertical cylindrical targets, 1 foot high and 6 inches in diameter, located along the street. While painted and sanded to simulate the street surface, the targets were comparatively somewhat less specular in character. The street was considered to be divided longitudinally into four lanes, and each inter-lamp section into five equal blocks—the limits being marked by white stakes driven into the ground alongside the road. In the first series of observations by pedestrians, the observers, ten in number, walked through the street at an average rate of 3 miles an hour, and recorded on a chart the disc targets as soon as seen, noting at the same time their location and the time taken. The results were expressed in "targets found per minute" in relation to the total targets "planted." A number of such tests were carried out; some 60 to 100 discs being placed in predetermined positions and their location altered by boys, both for each system of lighting tried and each promenade of the ground. The two systems were tested alternately, and the investigations made by the ten observers under varying conditions of experiment and fatigue. The results of the "finds" of the disc targets were tabulated in detail by Mr. Preston and then averaged, when it was found that under one system of lighting, designated "B" (which is assumed to be that of the 4-ampere magnetite lamps), 29 per cent. more targets were found than under system "A" (apparently of open arc carbon lamps); the targets found per minute of search being also greater by 28 per cent.

In the case of other observational tests, four cylindrical targets, 1 foot high and 6 inches in diameter, were prepared. These were placed along the street—one target in each of the four lanes into which the street was considered to be divided. With this method, three observers, in motor-cars, rode through the street at approximately 18 miles per hour, in order to ascertain the maximum distance at which the targets could be seen. Precautions were taken, as in the case of the disc target tests, to assure comparative results. The data obtained are summarized by the author. The average maximum perception distance for the three observers was 682 feet for system "B," 616 feet for system "A." Before proceeding to his deductions from the observational method of testing adopted, Mr. Millar admits its laborious and costly character; the number of men observers and assistants occupied during one night's work being 25, and the time engaged some 9 hours. He says such methods are not generally applicable, but may be applied only when extraordinarily important matters are involved. One cannot but agree with the author's adverb "extraordinarily," although reading with interest the conclusions he derived from the tests.

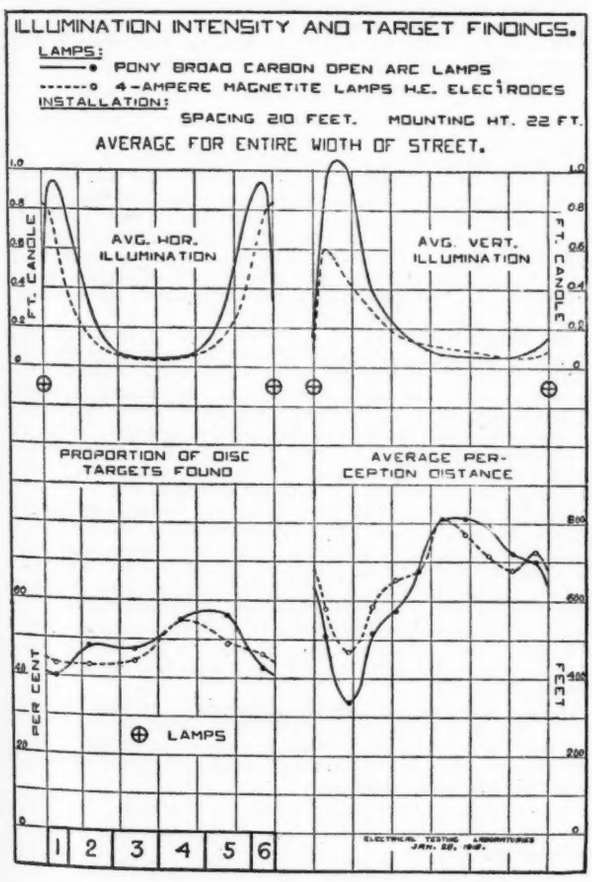
Before proceeding to these Mr. Millar makes certain comments on observational tests generally; and these perhaps suggest that the method is not altogether devoid of disadvantages. Among the variables to be taken into account are the size, colour, and contour of the targets. In proportion as the targets are rendered difficult to see, the test gets sensitive and capable of discovering

relatively small differences in the revealing qualities of any two systems of lighting. Yet in the necessity for making the targets difficult of observation, the system is rendered slightly favourable to uniform and unfavourable to non-uniform lighting. Again, the results in both the walking and riding tests may vary with the observer's physical qualities, the state of the street surface, and the condition of the atmosphere. Variations in physical conditions have a marked effect upon the percentage of targets found, and it would appear that results can only be regarded in a comparative sense. The author's elaborate method of testing therefore is not likely to displace photometric measurements of illumination, which have the relatively enormous advantage of affording comparative data, not merely of lighting systems upon different nights but in different towns.

Mr. Millar continued his paper by selecting from his data one comparison of the observational results obtained from lighting by pony broad carbon direct-current open arc lamps of 9·6 amperes and magnetite lamps of 4 amperes equipped with high efficiency electrodes. The results of a number of walking and riding tests are detailed, and then, with photometrical data, summarized as follows:

—	Open Arc Lamps.	Magnetite Arc Lamps.
Total lumens per lamp	5290	4649
Average foot candles, horizontal	0·35	0·24
" " " vertical	0·29	0·20
Observational test, relative results—		
Disc targets, pedestrians	100	98·7
Cylindrical targets, drivers	100	102·4

This summary is given as containing much interesting material; but one is inclined to think that it would have been more serviceable if particulars of the polar diagrams of the lamps had also been included, in order to get some idea of the maximum and minimum as well as the average foot candle values obtained. It is true a graph is furnished [reproduced] which indicates the illumination between lamp and lamp; but this is averaged across the whole street.



The author observes that the high peak in the neighbourhood of carbon arc lamps is due to the strong radiation of light at about 50° to the vertical. He points out that the observational test curves do not follow the curves of incident light, and that midway between the lamps where the illumination is relatively feeble the disc targets are found about as well as they are in the regions nearer the lamps where the intensity is high. This is regarded as definite evidence that intensity alone falls far short of providing an index to the effectiveness of the illumination. Mr. Millar, however, explained the good findings of targets at points midway between the lamps by the fact that shadows of objects and street surface irregularities become more pronounced, and at points near the lamps by the generally higher illumination. The explanation will not probably help in converting many to the author's views, since a method which allows both high and low illumination to give somewhat similar results can scarcely be looked upon as an index to the value of street lighting. A footpad might, for instance, be clearly discerned midway between two lamps, but the difficulty in afterwards identifying him in a police court would afford little satisfaction to the observer.

Mr. Millar later on explained that the low perception shown by the curve as compared with the high illumination obtained close to the lamps was due to the fact that substantially the same amount of light falls upon the target as upon the street beyond it which forms its background. This, again, does not seem to favour the observation as compared with the photometric method. In passing, it may be said that one of the illustrations in the paper shows the lamps on one side of the street only. This surely means that shadows opposite a lamp would be exceedingly short, and lie across the street. They would not, therefore, be so easily seen by observers as the longer shadows forming dark patches along the street.

The author states, in his "Conclusions," that some of the facts developed through these studies have "promoted sound consideration of the street lighting problem, and not the least conclusion indicated by the work is that the total flux of light produced by a street illuminant which is reasonably well adapted to street lighting is likely to be a pretty fair index of its illuminating value for street lighting purposes." He considers that the observational tests commend themselves especially because of their all inclusive character with respect to factors affecting the revealing qualities of the illumination. Glare, if present to a harmful degree, will affect the observations, causing the results to suffer; and if a particular distribution of light stimulates mental alertness, this will also be reflected in the tests.

In the discussion which followed delivery of the paper, favourable comment was made on the work done by Mr. Millar. Nevertheless, the fact was noted that the observational tests suggested the two systems of lighting to be practically on a par, while the total flux and average foot-candle values distinctly indicated the contrary, and explanation of the discrepancy was asked for.

In reply, Mr. Millar considered the figures as fully explained by the differences in light distribution characteristic, and by the fact that a 12 per cent. change in the amount of light produced in the street cannot be expected to influence ability to see appreciably—that is to say, the change in the stimulus produces but little change in the sensation. One cannot but think, however, that values derived from the ability to see objects by strong light near a lamp and by shadows at points remote from the illuminant, do not help in the same way as do photometric foot-candle measurements, in the attainment of good street illumination.

New Theory of the Long Life of Cast-Iron Pipe.

The "Bulletin of Abstracts" of the American Gas Institute suggests a new explanation for the claimed longer life of buried cast-iron pipe over rolled steel or iron pipe. The initial rusting of cast iron is pictured as taking place rapidly, owing to the impurities in it like phosphorus, sulphur, silicon, &c. But the rusting soon stops, since the undisturbed crystals are held together at one or more points by metallic bonds, and the surface rusting is so intermeshed with the irregular aggregations of crystals that the force exerted by the absorbed moisture is not sufficient to separate the crystals and the oxide. The rust, therefore, remains as a protective coating. Rolled metals, on the other hand, are pictured as having their original structure destroyed, and as consisting of a series of laminations and leaves which are easily dislodged when rusted.

Gas Consumption in Germany.—The statistics of gas consumption in Germany which have been given in the "JOURNAL" from time to time for each month since the outbreak of war were carried to the month of January last in our issue of June 6 [Vol. CXXXIV. p. 499]. Statistics for four more months, collected by the Central Gas Bureau in Berlin, are now available. In February this year, the production of 794 German gas-works was 12·6 per cent. greater than in February, 1915, and 6·9 per cent. greater than in the same month of 1914. For March, the figures refer to 788 gas-works; and the production in that month in 1916 was 9·8 per cent. greater than in 1915, and 6·2 per cent. greater than in 1914. In April last, the increase in production of 821 works was 10·7 per cent. over 1915, and 7·5 per cent. over 1914. In May, 813 German gas-works made 5·5 per cent. more gas in 1916 than in 1915, and 3·4 per cent. more than in 1914. The number of gas-meters in use shows a very large increase. In May last, 572 works supplied 7·7 per cent. more meters than in May, 1915, and 17·6 per cent. more than in May, 1914. The prepayment meters showed a still larger increase in numbers—viz., 16·9 per cent. more in May last than in May, 1915, and 44·2 per cent. more than in May, 1914. These figures relate to 467 gas-works. Further, in May last 53 gas-works were supplying 23,104 consumers at a fixed charge per installation; the gas consumed not being measured owing to lack of meters in sufficient numbers to meet the applications of new consumers.

THE "DIRECT" PROCESS FOR THE MANUFACTURE OF SULPHATE OF AMMONIA, AND THE STORAGE OF AMMONIACAL LIQUOR.

Details of an Inquiry, from the Annual Report of Mr. W. S. Curphey, Chief Alkali Inspector.

WHEN referring last week to the issue of the fifty-second annual report [for the year 1915] of Mr. W. S. Curphey, Chief Inspector under the Alkali Works Regulation Act, 1906, it was stated that full particulars were given therein of an inquiry in connection with the adoption by gas-works of the direct process of sulphate of ammonia manufacture, which had been undertaken to endeavour to ascertain the directions in which improvement might be looked for, both with respect to more regular working of the purifiers and a higher yield of sulphate. We now reproduce this section of Mr. Curphey's report, together with his remarks on the subject of the storage of ammoniacal liquor.

The direct methods for the production of sulphate of ammonia were further extended in coke-oven works and in gas-works. In coke-oven works, the advantages are clear and generally recognized. In gas-works, however, there has been varying experience as regards the influence of this method upon the action of the oxide of iron purifiers through which the illuminating gas subsequently passes prior to distribution among consumers. This influence has been so prejudicial in many works where the expectations of high returns of sulphate have not been realized, that it was considered worthy of special consideration. The following remarks on the results so far obtained indicate that, with modifications in procedure, greatly improved returns may be anticipated in certain cases.

THE DIRECT PROCESS IN GAS-WORKS.

The first works of this type to be registered under the Alkali Act was erected in 1910. At the start, the process was adopted only in works of small size. But growing confidence in its efficiency has led to more extended use; and it is now in successful operation in works making half-a-million cubic feet of coal gas per day. At the present date, 21 plants are under inspection; and at two additional works ammonia scrubbers of the usual type have been supplemented by the addition of a secondary scrubber of the direct type, fed with acid through which the crude gas passes on its way to the purifiers.

Experience with the working of the direct process varies widely with respect to freedom from purifier trouble and yield of sulphate. At one works, purifiers are a chronic source of trouble; at others, the process has worked continuously for two, three, and even four years without trouble of any kind. The yield of sulphate in the majority of works has been much below the anticipated figure. Out of thirteen works from which returns have been received, five have recovered less than 17 lbs. of sulphate of ammonia per ton of coal carbonized, six less than 18 lbs., ten less than 21 lbs., eleven less than 25 lbs., and at two works only has the make exceeded this figure, with a yield approaching 28 lbs. These figures are disappointing. Properly worked, the process should undoubtedly yield a return exceeding that obtained with the older process, in which a make of 22 lbs. per ton is usually looked for. Storage losses would in general be greater with the older process, which necessitates the handling and storage of large volumes of ammoniacal liquor relatively rich in free ammonia. Apart from the recovery of sulphate of ammonia, however, the adoption of the direct process has been of advantage where spent liquor has been difficult to dispose of. This inquiry has been undertaken in the hope that, by a close study of the conditions favoured at various works, and by an analysis of the products, data might be obtained which would indicate the directions in which improvement might be looked for, both as to more regular working of the purifiers and a higher yield of sulphate.

It is a well-established fact in gas-works practice that the coal-gas purifiers require for efficient working a certain small proportion of ammonia—say, 0·5 to 2 grains per 100 cubic feet of crude gas entering the system. This amount is usually present in ordinary gas-works practice, as the ammonia scrubbers never perfectly fulfil the function for which they exist. Conditions of working differ widely in the direct process, as the scrubbers fed with water are omitted, and their place taken by an acid arrester or bubbler of special design, in which the crude coal gas meets with dilute sulphuric acid in amount more than sufficient to extract the full ammonia content. At first, it was thought possible that the irregular working of the purifiers which was a feature at so many of the works when the process was in its infancy was due to complete abstraction of the ammonia by the acid, resulting in a neutral or acid condition of the oxide which was prejudicial to its efficiency.

Dr. Fryer's tests, however, are conclusive on this point. In no case has ammonia been found to be absent in the gases entering the purifiers, and in general the amount is found to exceed the proportion met with in gas-works practice; and Dr. Fryer's experience is confirmed by analysis of samples of spent oxide from the direct process, which are unusually rich in ammonia compounds. It is a significant fact, however, that in all cases where purification in the direct process has been a chronic source of trouble, the desired cure has been effected by directly increasing the supply of ammonia to the purifiers, either by the use of a bye-pass connection short-circuiting the acid arrester or by causing the gas on its way to the purifier to pass through a washer fed with ammoniacal liquor. Indeed, the lavish freedom with which ammonia is supplied to the purifiers, so as to ensure freedom from irregular working, is considered responsible in great measure for the low yield of sulphate at the works where it is practised.

The following examples are cited by way of illustration: At one works, where the make of gas exceeds half-a-million cubic feet per day, crude gas has on occasion been bye-passed continually to the purifier by a 2-inch pipe; and, in addition to this, for about half-an-hour on each day the acid arrester has been bye-passed, and the whole of the crude gas sent direct to the purifiers. At this works, spent oxide from the bottom grid on one occasion was found to contain 12·8 parts of total ammonia, calculated as sulphate, per 100 parts of oxide dried at 100° C., equivalent to 22 parts of ammonium sulphate per 100 parts of total sulphur in the oxide. At a second works, the oxide from each of the three grids smelt strongly of ammonia; and the total ammonia present in the sample from the bottom grid was 32½ parts per 100 parts of oxide, calculated as sulphate on the dry basis.

It is clear, therefore, that there is no deficiency of ammonia in the crude gas entering the purifiers, judged by comparative standards. Why, then, does it fail to produce the desired result? Is the irregular working of the purifiers due to actual shortage of ammonia on the occasions when they fail, or are other causes at work which render its beneficial effects inoperative?

Before discussing the data supplied by the managers of the various works under inspection, and disclosed by analyses of the spent oxide and other products, it is desirable to consider with some care the character of the reactions that take place in the purifier system under ordinary working conditions.

PURIFICATION OF CRUDE COAL GAS BY OXIDE OF IRON.

Crude coal gas from the scrubbers in ordinary gas-works practice contains 0·8 to 2 per cent.* of H_2S, 1 to 3·5 per cent. of CO_2, and 50 to 100 grains of HCN, together with traces of free ammonia—say, 0·5 to 2 grains per 100 cubic feet—and free oxygen drawn in by the exhauster at the retorts or admitted designedly to aid the purification process. The function of oxide purifiers is mainly concerned with the removal of sulphuretted hydrogen; and their efficiency is measured by the volume of crude gas purified prior to exhaustion. But the removal of certain other impurities—*e.g.*, hydrocyanic acid and ammonia—is also effected at the same time, and is of importance.

The general properties of hydrated oxide of iron and its behaviour towards sulphuretted hydrogen have been closely studied by many chemists; but the rationale of the process is by no means clear. The purification process is considered to occur in two stages: First, a sulphiding stage, during which the oxide (or hydrated oxide) reacts with sulphuretted hydrogen to form a sulphide (or sulphides) of iron; and, secondly, the oxidation stage, during which the sulphide of iron is re-oxidized with formation of oxide (or hydrate) of iron and free sulphur.

In older practice, the oxidation stage was usually carried on outside the purifier; and the sulphided material was removed from the purifier for the purpose. In the best modern practice, the sulphiding and oxidizing stages are carried on within a closed system—the rotation system—and the working of the boxes is so regulated that each in turn passes successively through the critical stages, until the oxide is fully spent and ready for discharge. The procedure finds illustration in a recent paper by Mr. W. Bennett, of Greenock, read before the Scottish Junior Gas Association, Western District.†

Various equations have been put forward to account for the results obtained in practice. According to Gedel, the reactions that take place during the sulphiding stage are governed by the conditions of the oxide. When the conditions are slightly alkaline, ferric sulphide alone is formed—

$$(1)\quad Fe_2O_3.xH_2O + 3H_2S = Fe_2S_3 + (x+3)H_2O.$$

When neutral or faintly acid, ferrous sulphide and free sulphur are produced—

$$(2)\quad Fe_2O_3.xH_2O + 3H_2S = 2FeS + S + (x+3)H_2O.$$

The desired reaction, he states, is that represented by equation (1), since ferrous sulphide and free sulphur tend to react, forming iron disulphide (FeS_2), an inert body that resists oxidation, and is removed, therefore, from the cycle of reactions upon the due completion of which the efficiency of the purifying system depends. In both cases small quantities of ferrous sulphate are formed, in amount increasing as the temperature rises.

* Thorpe's "Dictionary of Applied Chemistry," Vol. II., Edition 1912, Article "Coal Gas."

† See "JOURNAL," Vol. CXXXIII. p. 419.

The function performed by the ammonia in affecting the products of sulphiding is obscure; and further investigation is called for. It may be stated, however, that investigations conducted in this laboratory on the sulphiding of oxide of iron under neutral conditions affords some support to Gedel's views. Thus, with pure oxide of iron sulphided in an atmosphere of pure sulphuretted hydrogen, and therefore under neutral conditions, 11 per cent. of free sulphur was obtained and 0·2 per cent. of sulphur as ferrous sulphate. On revivification, the free sulphur produced was 94·7, sulphur as sulphate 0·9, and as disulphide 4·4 per cent. of the total. No opportunity was found to carry out the sulphiding in the presence of traces of ammonia. The formation of free sulphur under neutral conditions, however, is very partial. Had sulphiding proceeded entirely on the lines indicated by equation (2), the yield of free sulphur should have approximated to 30 per cent., allowing for the FeS_2 formed.

The oxidation stage may be represented by one or other of the following equations—

(1) $2Fe_2S_3 + 3O_2 + 2xH_2O = 2Fe_2O_3.xH_2O + 6S.$
(2) $4FeS + 3O_2 + 2xH_2O = 2Fe_2O_3.xH_2O + 4S.$

Such are the reactions that are supposed to take place under the simplest working conditions, when sufficient free oxygen is present to complete the re-oxidation of the sulphide. In effect, the oxide of iron acts as a catalyte that induces the reaction—

$$6H_2S + 3O_2 = 6H_2O + 6S.$$

Considering the reactions a little more closely, we see that during the sulphiding stage water is set free and tends to accumulate in the mass; during the oxidation stage, rehydration takes place, and the moisture-content of the mass is diminished. For equilibrium the water produced by oxidation of the sulphuretted hydrogen must be removed by the residual gases; and temperature conditions should be such as to effect this with least disturbance to the system. It is reasonable to conclude that, for maximum efficiency, sulphiding should take place under conditions which bring material richest in hydrated oxide of iron into contact with crude gas containing the maximum amount of sulphuretted hydrogen and free ammonia, and where the tension of aqueous vapour is at a minimum; and oxidation under conditions which bring material richest in sulphide into contact with crude gas containing the minimum amount of sulphuretted hydrogen, and where the tension of aqueous vapour is at a maximum. The sulphiding process generates a small amount of heat, the oxidation process a large amount of heat; and to effect rehydration of the oxide under these conditions the aqueous tension must be high.

Hydration of Oxide.

The advantage of maintaining the purifying material in a condition of suitable humidity has long been recognized in practice. An insufficient amount of moisture is found to be prejudicial to efficient purification, equally with an excess of moisture. J. T. Sheard lays down the rule ["Journal of Gas Lighting," April 11, 1893, p. 633] that the oxide should be moistened as much as, and no more than, will agglomerate its friable powder into a light granular condition, and enable it to hold together on the grids. Lewis T. Wright [Thorpe's "Dictionary of Applied Chemistry," First Edition, Vol. II., Article, "Coal Gas"] considered that the oxide should contain from 10 to 20 per cent. of moisture. W. R. Chester [29th annual meeting of the Gas Institute, June, 1892] stated that efficiency is at a maximum when 4 per cent. of moisture is present. For large purifiers, he would advise 4 per cent., for small 10 per cent. The question in its relation to purifiers worked in connection with sulphate of ammonia works (distillation process) was very fully considered in the annual report for 1911 and 1912*; and the conclusion was there reached that bog ore or revivified oxide containing about 10 per cent. of moisture is in a very suitable condition for sulphiding.

It has to be remembered, however, that, apart from the phyical condition of the oxide originally charged into the purifiers—bog ore or artificial—the character of the material is progressively undergoing change as the proportion of free sulphur and associated impurities increases. An oxide that contained at the start (say) 60 per cent. of reactive hydrate, $Fe_2O_3.xH_2O$, at the end, and when fully spent, may contain less than 25 per cent. The hydration condition of the oxide—*i.e.*, the amount of water combined with the ferric oxide to form hydrates of greater or less stability under purifier conditions—may profoundly affect the reactive capacity of the oxide; and a degree of "moisture"—*i.e.*, water expelled at 100° C.—that may be suitable when the material is relatively rich in ferric oxide, may be unsuitable when it is more or less spent, and relatively poor in ferric oxide.

Ferric hydrate, $Fe_2O_3.H_2O$, is stable at 100° C. At lower temperatures, and in contact with vapour of water, moisture is absorbed until equilibrium is reached. $Fe_2O_3.3H_2O$ (if capable of existing under suitable conditions) would lose $2H_2O$ when heated to 100° C.—*i.e.*, its "moisture" content would be 16·8 per cent. A bog ore containing reactive oxide equivalent (say) to 70 per cent. $Fe_2O_3.3H_2O$—apart from uncombined moisture—would contain $0·7 \times 16·8 = 11·8$ per cent. of moisture; a partially spent oxide with 35 per cent. $Fe_2O_3.3H_2O$, about 6 per cent. moisture. When adjusting the moisture-content of the purifying material, therefore, regard should be paid to the progressive diminution in the proportion of reactive hydrate ($Fe_2O_3.xH_2O$) present as free sulphur and other impurities accumulate in the mass. Any moisture in excess of that required to maintain the reactive oxide in a due state of hydration is likely to lower the purifying efficiency of the material.

It is an established fact [*see* Wm. Bennett, *supra.*] that oxide may remain efficient when it is physically in what may be termed a very "dry" condition. The moisture content of oxide from the "hurdle" grids at Greenock, with downward flow of gas, when removed from the purifiers, was:

Top caking portion, 5·38 per cent.; centre, 1·92; bottom, 1·42.

Assuming that the ferric hydrate ($Fe_2O_3.3H_2O$) content of the moist oxide was 27 per cent., the moisture content per 100 parts of ferric hydrate would be:

Top caking portion, 20·0; centre, 7·1; bottom, 5·3.

And $\frac{27}{100}$ 16·8 = 4·5 for pure $Fe_2O_3.3H_2O$ diluted to 27 per cent. strength.

When adjusting the moisture content of an oxide, consideration must be paid to the working temperature of the system. In the absence of a suitable amount of moisture, and with admission of air, there would be danger of firing under exceptional conditions were the oxide to be used too dry.

Temperature.

The effect of temperature on purifier working in sulphate of ammonia (distillation) works was very fully discussed in the annual reports for 1911, 1912, and 1913.* Experience is lacking with respect to the working temperature of gas-works purifiers. Dr. Colman ["Dictionary of Applied Chemistry," Vol. II., Article, "Coal Gas." Edition 1912] gives 15° C. (say, 60° Fahr.) as the minimum temperature for efficiency—"below that temperature the action of the oxygen becomes very slow." Mr. William Bennett states that most oxides have their highest efficiency about 80° Fahr. (27° C.). At Greenock, where the forward rotation system is in use, the temperature aimed at is 65° Fahr. (18½° C.). At a temperature much below 50° Fahr. (10° C.) the oxide becomes sluggish. For this reason a steam-pipe is in use, placed at the bottom of the purifier, to regulate the temperature.

It was stated above that the sulphiding stage is accompanied by the production of water $(x + 3)$ H_2O. Of this amount, xH_2O is required during the oxidation stage for rehydration of the oxide, $3H_2O$ (corresponding to the sulphuretted hydrogen—$3H_2S$—absorbed) is excess moisture, and has to be removed from the system. On theoretical grounds, therefore, and apart from the effect of rise of temperature on the reactive capacity of the oxide for sulphuretted hydrogen, the minimum temperature of the gas should be such as to enable it to carry the whole of the water set free *plus* that entering in the form of aqueous vapour.

Let us assume that the crude gases enter the purifier at 50° Fahr. (10° C.) and that 1 per cent. of H_2S is present.

On oxidation, 1 per cent. of H_2S yields 1 per cent.

H_2O, corresponding to $\frac{1}{100} \times 760$ m.m. . .	7·60 m.m.
Assuming saturation at 50° Fahr., the aqueous tension of the entering gas would be	10·10 „
Total	17·70 m.m.

Aqueous tension 17·7 m.m. corresponds to saturation at 20° C. (68° Fahr.).

If the crude gas enters saturated at 60° Fahr. (15·5° C.) the final tension would be 23·2 m.m., corresponding to saturation at 25° C. (77° Fahr.). A working temperature of 70° to 80° Fahr. (21° to 27° C.) would thus appear to be a very suitable temperature in the sulphiding zone. The moisture thus set free and carried forward by the warm gas would be beneficial in the oxidation zone. During revivification, rehydration of the oxide is taking place and moisture is being absorbed. Rise of temperature is favourable to oxidation; and with moist gas evaporation is checked and heat conserved.

Those interested in the thermo-chemistry of the purification process will find the matter fully discussed in the report for 1911.

Impurities in the Crude Coal Gas.

We have now to consider the effect upon purification of impurities other than sulphuretted hydrogen entering with the crude gas and absorbed by the oxide:

(1) Tar fog, oils, and naphthalene.
(2) Hydrocyanic acid.
(3) Ammonia.
(4) Sulphur compounds other than sulphuretted hydrogen.

(1) *Tar Fog, Oils, and Naphthalene.*—Oxide of iron is an efficient filter, and would remove the whole of the tar fog and part of the condensible oils and naphthalene. This would tend to throw back-pressure on the system, and would check diffusion of the sulphuretted hydrogen into the pores of the oxide.

(2) *Hydrocyanic Acid*, and (3) *Ammonia.*—Hydrocyanic acid is undoubtedly prejudicial to the efficient working of purifiers. Apart from any direct action it may possibly have on sulphides of iron, liberating sulphuretted hydrogen, it reacts with oxide of iron in the presence of ammonia to form insoluble iron ferrocyanides and double ferrocyanides of iron and ammonium (crude Prussian blue) as well as ammonium sulphocyanide. If such reactions take place oxide of iron is rendered inert, the reactive residue is coated over by insoluble bodies and rendered less porous, and the ammonia needed to neutralize the ferrous sulphate and maintain

* See "Journal," Vol. CXV., p. 20, and Vol. CXIX., p. 324.

* See "Journal," Vol. CXXIII., p. 238.

the condition of mild alkalinity essential for the efficient purification is fixed and rendered inert.

When it is remembered that the amount of hydrocyanic acid normally present in the crude gas entering the system is fifty to a hundred times the amount of the ammonia, and that the presence of free ammonia is regarded as essential to efficient purification, one is not surprised that purifier troubles are frequent when normal conditions of work are departed from. It is pertinent to ask what conditions favour interaction of hydrocyanic acid and ammonia to form ferrocyanide and sulphocyanide. Experimental proof is lacking; but one would conclude that excess of moisture is really the determining factor.

In the presence of moisture, ammonia and hydrocyanic acid are dissolved and brought into intimate contact with iron oxide and sulphide on the one hand, and with sulphuretted hydrogen and free sulphur on the other, and at a slightly raised temperature. These are conditions favourable for the formation of double cyanides and sulphocyanide. Thus—

$$(1)\ 2FeS + 6NH_4CN = (NH_4)_2Fe_3(CN)6 + 2(NH_4)_2S.$$
$$(2)\ -(a)\ (NH_4)_2S + 2S = (NH_4)_2S_3.$$
$$(b)\ (NH_4)_2S_3 + 2HCN = 2NH_4CNS + H_2S.$$

The conclusion here reached, that excess of moisture is favourable to the fixation of ammonia and is one of the causes responsible for purifier troubles, finds confirmation below in the discussion of the facts relating to the direct process.

(4) *Sulphur Compounds Other than Sulphuretted Hydrogen.*—No evidence exists with respect to specific action of such compounds on oxide in the purifiers. Mr. William Bennett has made a preliminary experiment which is suggestive; but it is well to suspend judgment until further evidence is forthcoming.

Conclusions.—These considerations lead one to infer that the following conditions are those best suited to maintain the purifiers at their highest efficiency, and the best modern practice is in conformity therewith.

1. Due hydration of the oxide—(say) 5 to 10 per cent. of moisture; such hydration having regard rather to the reactive ferric hydrate content of the mass than to the total mass of material, active and inert.
2. *Temperature.*—(*a*) Crude gases entering the system to be dry and cool rather than moist and warm. Low moisture content is the essential requirement. (*b*) Oxide.—Temperature in the sulphiding zone to be such as to enable the gas to carry as vapour the whole of the moisture equivalent to the sulphuretted hydrogen absorbed—say, 70° Fahr. (21° C.). The temperature in the oxidation zone to approximate to this; so that water of hydration set free in the sulphiding zone, and retained in the sulphided mass, may be reabsorbed through hydration of reformed ferric oxide, and not carried away in the exit gas and lost to the system.
3. *Impurities.*—The crude gas should be freed, as far as possible, from tar fog, oils, naphthalene, and hydrocyanic acid, and should contain a trace of ammonia—say, 0·5 to 1 grain per 100 cubic feet—and oxygen equivalent to half the volume of sulphuretted hydrogen present.
4. *Purifier Boxes.*—These should be protected from the cold, and should be worked in rotation in such a way as to bring the material richest in ferric hydrate into contact with gas richest in sulphuretted hydrogen, and the material richest in sulphide into contact with the gas poorest in sulphuretted hydrogen.
5. *Direction of Flow.*—This should be downwards, not upwards. Area of contact is thus increased and risk of caking diminished, and pressure tends to equalize itself, and the rate of flow is thereby rendered more uniform.
6. *Regulation of Working.*—Conditions throughout should be as regular as possible. Material assistance would be afforded were it possible to record the temperature of the oxide in the boxes and in the inlet and outlet gas-mains, and the oxygen content of the gas.

Works Tests.

The investigations are still incomplete; and it is necessary, therefore, to speak with reserve. But there is little reason to doubt that the working of the direct process leaves much to be desired, and that the procedure followed in many of the works is gravely open to question. If the conclusions reached above with respect to the principles that should guide the gas manager in his conduct of the purifying process are justified in practice, there is good reason for believing that the irregular working of the purifiers in the direct process is mainly due to the low temperature and the excessive moisture of the oxide—a condition that arises partly from undue exposure to the weather and in part to the excessive humidity of the gases that enter from the acid scrubber. It is significant that out of nineteen works from which returns have been received, twelve are works where purifiers are in the open, six only where purifiers are covered, and one where they are partly covered and partly in the open. A similar disregard of precautions is shown with respect to the revivifying floors. Of these, ten are in the open, nine only under cover, and of those under cover some at least are open at the sides and exposed to driving rain. The figures presented in Table II. afford undoubted proof that the amount of moisture in the oxide is often far in excess of requirements. Purifier troubles have been most frequent at works where oxide has been very moist, and less frequent or absent where oxide has been dry. At works A, with a yield of 28 lbs. of sulphate per ton of coal carbonized, both purifiers and revivifying floor are under cover and well protected from the weather. Oxide from the bottom grids is stated to be uniformly dry at these works, moist only on the upper grids. At works G, with a yield of 17 lbs. s/a oxide, when examined, was found to be wet on both grids; and the degree of moisture is said to increase with the cold weather. Purifiers are in the open here.

In judging of the condition of any given spent oxide, *quâ* moisture, it should not be forgotten that the foul purifier before being opened is always placed first in the direct process, and therefore contains the maximum amount of sulphide. It was pointed out above that, during sulphiding, water of hydration is set free in addition to water formed by decomposition of the sulphuretted hydrogen. This water of hydration is needed in the revivifying stage, and its presence in the sulphided mass is therefore appropriate. Water of decomposition, on the other hand, should be removed as vapour by the crude gas. Spent oxide in the sulphided state should therefore be moister than spent oxide after oxidation, whether this be carried out *in situ* in the tail boxes or on the revivifying floor.

When comparison is made between the working of the purifiers in the direct process and those operating in the older process, it is important to remember that the scrubbers in the two types of plant perform very different functions. In the older process, the water-fed scrubbers remove a notable amount of sulphuretted hydrogen, hydrocyanic acid, and vesicular tar fog, when this happens to be present; and to this extent they afford relief to the purifiers. Such scrubbers are placed in the open, and during the winter months, when the make of gas is at a maximum, must exert a beneficial effect upon the gases by reducing to a minimum the proportion of aqueous vapour. The scrubbers, further, have an equalizing effect upon the ammonia, and ensure that a certain small proportion of this constituent is constantly present in the crude gases entering the purifiers. On the other hand, the acid bubbler attached to the direct plant works at a relatively high temperature. It is often placed under cover, interaction of ammonia and acid generate heat, and the temperature of the liquor is further raised by the entry of steam and ammonia from the virgin liquor still. The scrubbed gas leaves at a relatively high temperature and carries with it to the purifiers an amount of aqueous vapour that cannot but be prejudicial to the working of the oxide. Conditions are aggravated by the intermittent working of the virgin liquor still at many of the works. This must be extremely disturbing to the purifying system when a secondary washer fed with ammonaical liquor is not interposed between the acid bubbler and the purifiers to cool the gases and equalize the amount of ammonia carried forward.

The following temperatures were recorded at one works when the virgin liquor still was in action on Nov. 3, 1915:

	Temperature,
Crude gas entering the "acid bubbler"	50° Fahr.
Effluent liquor from "	90
Crude gas leaving "	64
" " " rotary fed with virgin liquor	55
" " " first purifier	60
" " " last purifier	55

At another works, on the same date, with the virgin liquor still idle:

Crude gas entering the acid bubbler	56° Fahr.
Effluent liquor from "	56

At a large works, where the make of gas exceeds half-a-million cubic feet a day, the manager states that the temperature of the crude gas entering the acid bubbler averaged 55° Fahr. for a period of fifteen weeks (maximum temperature, 62·5° Fahr.; minimum, 50° Fahr.), and the temperature of the gas leaving the bubbler 75° Fahr. (maximum, 84·°5 Fahr.; minimum, 61° Fahr.), a rise of 20° Fahr. (11° C.).

It was thought possible at one time that failure of the purifiers was due to the accumulation within the mass of a large proportion of secondary products, ferro sulphate and iron disulphide (FeS_2), causing the oxide to assume the sour condition so characteristic of the oxide in certain Scottish works where sulphate is made by the distillation process [*see* "Annual Report," 1913]; but the results of analysis do not support this view. Disulphide does not appear to be produced in quantity in oxide purifiers dealing with crude coal-gas at any of the works; and the highest percentage of disulphide (5·3 parts per 100 parts of total sulphur, Table III.) was found at works "A," which have operated for 2½ years without trouble of any kind, and has the highest yield of sulphate of ammonia—28 lbs.

The high proportion of total ammonia to sulphur soluble in carbon bisulphide in the spent oxide from the direct process at once commands attention. An undue supply of ammonia to the purifiers is not regarded in itself as being necessarily harmful, *quâ* purification. The spent oxide from one works where the oxide had worked without failure for some weeks was found to contain 32½ per cent. of ammonia calculated as sulphate, much of it being present as sulphocyanide; and the liquor draining from the bottom grid contained 29·7 grammes of total ammonia calculated as sulphate per 100 c.c., (24·7 grammes of which was present as ammonium sulphocyanide); yet the purifier working, it was said, fulfilled expectations and the spent oxide revivified readily. But the presence of a high proportion of ammonia undoubtedly affords proof of improper and wasteful working. Had the oxide been kept at a suitable temperature, and in a proper state of hydration, traces of ammonia entering with the crude gas should have sufficed

to maintain its efficiency. The excess was undoubtedly condensed and fixed as sulphocyanide.

Considering the tables in detail, Table I. shows the results of the comparative working of representative types of plant.

TABLE I.—*Comparative Working of Representative Types of Plant.*

—	Works "A."	Works "G."	Works "D."	Works "I."
Pounds of sulphate of ammonia per ton of coal carbonized	28	17	19½	12½
Any purifier trouble and how prevented	No trouble	Occasional trouble	No trouble	No trouble
Ammonia bye-passed	No	By 1½ in. pipe	No	No
Washer fed with virgin liquor	No	No	No	No
Virgin liquor distilled	Yes	Yes	Yes	Yes
Coal used and gas made:				
Class of coal	Derbyshire	South Yorkshire	South Yorkshire	South Yorkshire
Gas, make per ton of coal, c. ft.	11,500	11,500	13,700	13,700
Gas, maximum make, c. ft., per 24 hrs.	324,000	168,000	31,000	130,000
Purifiers:—				
Number in use	6	4	2	4
Number of grids	2	3	2	2
Exposed to weather or covered	Covered	Much exposed	Exposed	Exposed
Fouled box, position in series	First	First	First	First
Direction of gas	Upwards	Upwards	Upwards	Upwards
Oxide of iron:—				
Character	Mostly bog ore	Mixed bog and artificial	Bog ore	Artificial
Volume, c. ft. per ton coal per 24 hrs. (maximum make)	84	69	140	100
Volume, c. ft. per 1000 c. ft. gas made (maximum make)	7·3	6	11 3	7·7
Moisture in spent oxide, per cent.:				
Top grid	14·2	17·4	30·4	37·5
Middle grid	(None)	2·7	(None)	(None)
Bottom grid	8·0	10·4	8·5	30·5
Moisture. Top grid per 100 parts of $Fe_2O_3, 3H_2O$	66	72	166	153
How revivified	Under cover	Under cover	Under cover, if wet	Under cover
Analysis of oxide, bottom grid:—				
Character prior to revivification	Dark grey	Dark brown	Dark grey	Brown
Behaviour towards litmus	Acid	Strongly alkaline	Acid	Strongly alkaline
Ferrous sulphate	Traces	*Nil*	Traces	*Nil*
"Moist" or "Dry"	Dry	Wet	Dry	Wet
After revivification at 30° C. (per 100 parts dried at 100° C.):				
*Sulphur soluble in CS_2	46·3	32·7	57·6	33·1
Sulphur as sulphocyanide	0·2	10·8	·4	3·5
Total ammonia, calculated as $(NH_4)_2SO_4$ per 100 parts sulphur soluble CS_2	2·2	99·0	5·7	47·0

* Oil and tar included.

At works "A" results have been consistently good from the start (2½ years ago), in spite of the fact that the annual make of gas has increased from 3 millions to 70 millions per annum. No ammonia is bye-passed, nor is any washer in use fed with virgin liquor or water. The crude gas passes to the purifiers by a short underground flue; and the purifiers and purifying floor are both under cover and well protected from the weather—gas passing upwards through the boxes. When examined, the spent oxide from both grids was found to be acid to litmus and contained traces of ferrous sulphate; and the liquor condensed in the foul-gas main and draining from the purifiers was acid to litmus and likewise charged with traces of ferrous sulphate. The total ammonia in this liquor, calculated as sulphate, was only 0·25 gramme, and the greater part of this was present as sulphocyanide. Analysis of the spent oxide confirms the impression that very little ammonia passes the acid bubbler. Bog ore is mostly used here. The spent oxide is stated to work dry on the bottom grid, and moist on the top grid. The amount of sulphate recovered in 1915 was 28 lbs. per ton of coal carbonized—a very satisfactory figure.

At works "G," the purifiers have on occasion given very great trouble. Irregular working was first noticed, when the make of gas began to rapidly increase, in November, 1915. The purifiers are in the open here. These and the revivifying floor are much exposed to rain and cutting winds; and the spent oxide is noticeably moist. Crude gas is regularly bye-passed by a 2-inch pipe. The engineer proposes to screen the revivifying floor at the sides and enlarge it, and to place a steam-pipe below the bottom grids. A rotary washer fed with virgin liquor is also being tried.

The results obtained at works "D" and "I" are extremely significant. At these works carbonizing conditions are precisely similar in respect of the coal used and the method of charging and heating the retorts, the make of gas per ton of coal is the same, at both works the purifiers are in the open, and at both oxide is revivified under cover when weather conditions are unfavourable. Yet the amount of sulphate recovered differs widely—being 19½ lbs. per ton at "D" and only 12½ lbs. at "I." At neither works is ammonia bye-passed, nor is any secondary washer in use. The acid bubblers are of the same type and size.

It is significant, however, that the make of gas at "D" is only one-quarter of that at "I." Spent oxide is noticeably dry at "D" and moist at "I." It is probable, therefore, that the acid bubbler is overworked at "I," and that an undue amount of moisture condenses in the purifiers. There is freedom from purifier trouble at both works; but at "I" this freedom appears to be purchased at the cost of a greater loss of ammonia. The moisture content of the spent oxide was dangerously high when samples were last taken—37·5 per cent. of moisture on the top grid and 30·5 per cent. on the bottom one, with a total ammonia content on the bottom grid of 15·5 per cent. calculated as sulphate, of which 47 per cent. is present as sulphocyanide.

A further difference is noticeable that may have significance. Bog ore is used at "D;" artificial, at "I." The engineer has now under consideration plans for the entire reconstruction of the plant at works "I." The significance of the figures has been already referred to above.

In Table III. comparative figures are presented showing the approximate composition of revivified oxide (average for all grids) from the purifiers at typical works where the direct process is in operation, and at two gas-works where the older process is being used. The results are remarkably uniform; but the higher yield of free sulphur at the two gas-works "J" and "K" is significant. Samples from works "J" and "L" were revivified in the open; the remaining samples under cover. The figures given in the last column relate to pure hydrated oxide sulphided in the sulphuretted hydrogen burette in the absence of ammonia, as described in the annual report for 1913.

In Table IV., the analytical figures show the composition of the spent oxide obtained from the various grids at one works where purification has given much trouble, and at works "A." The high proportion of total ammonia to sulphur soluble in carbon

TABLE II.—*Moisture in Spent Oxide as Removed from the Grids.*

Works.	"A."	"B."	"C."	"D."	"E."	"F."	"G."	"H."	"I."
Purifiers, covered or exposed	Covered	Exposed	Covered	Covered	Covered	Exposed	Exposed	Covered	Exposed
Pounds S.A per ton of coal carbonized	28	24¾	20	19½	18½	18	17	16½	12½
Character of oxide	Mostly bog ore	Bog ore	Bog ore	Bog ore	Artificial	Bog ore	Mixed bog and artificial	Artificial	Artificial
Spent oxide, undried:									
Moisture, per 100 parts:									
Top grid	14·2	"Hurdle" grids	9·5	30·4	20·5	16 7	17·4	2·1	37·5
Middle grid	(None)	18·9	(None)	(None)	14·8	(None)	2·7	4·5	(None)
Bottom grid	8·0	..	6·7	8·5	9·0	16·1	10·4	8 8	30·5
Moisture, per 100 parts of ferric hydrate ($Fe_2O_3 3H_2O$):									
Top grid	66	..	60·0	166	154	104	72	43	153
Middle grid	(None)	88	(None)	(None)	99	(None)	11	8	(None)
Bottom grid	38	..	34	45	76	100	49	25	136
*Sulphur (sol. CS_2) per 100 parts of dried oxide—average, all grids	44·4	56 6	60·0	54·0	61·7	56·0	46·4	29·4	32 5
Total ammonia, bottom grid, calculated as $(NH_4)_2SO_4$, per 100 parts of sulphur, soluble in CS_2	2·2	3·5	8·7	5·7	23 0	4·1	99·0	4·2	47

* Includes oils and tar.

TABLE III.—*Analysis of Spent Oxide from Various Sources.*

—	Ordinary Gas-Works.		Direct Process.				Sulphuretted Hydrogen Burette.
	Purifiers Give no Trouble.		Purifiers give Trouble.		Purifiers Give no Trouble.		
	Oxide Revivified.		Ammonia Bye-Passed.		Rotary fed Virgin Liquor.	No NH_3 Bye-Passed; no Rotary.	
			Oxide Revivified under Cover.				Oxide Revivified at 30° to 40° C.
	In Open.	Under Cover.	Sample, Oct. 25, 1915.	Sample, Nov. 17, 1915.	Oxide Revivified in Open.	Oxide Revivified under Cover.	
Works	"J."	"K."	"E."		"L."	"A."	..
Character of oxide	Dutch bog ore	Dutch bog ore	Lux with addition of some saw dust		Bog ore	Mostly bog ore	Pure ferric hydrate
Pounds S. A. per ton coal	23	22	18½		..	28	..
Spent oxide, revivified at 30° C.:							
Total ammonia, calculated as $(NH_4)_2SO_4$ per 100 parts total sulphur	3·6	8·4	16·4	14·5	..	2·2	..
Per 100 parts dried 100° C.:—							
Sulphur soluble in CS_2*	60·20	58·20	49·93	57·03	46·50	42·90	33·12
,, as sulphocyanide	·25	·60	·79	1·06	·30	·20	..
,, as sulphate, &c.	·60	·55	1·86	1·23	·41	2·05	·69
,, other forms (by diff.) partly FeS_2	1·65	1·55	1·76	1·46	2·47	2 53	1·09
Total	62·70	60·90	54·34	60·78	49·68	47·68	34·90
Distribution of sulphur:—							
Per 100 parts of total sulphur:							
Soluble in CS_2*	96·0	95·6	92·0	93·9	93·6	90·0	94·9
As sulphocyanide	·4	1·0	1·4	1·7	·6	4	..
As sulphate, &c.	1·0	·9	3·4	2·0	·8	4·3	2·0
Other forms (by diff.) partly FeS_2	2·6	2·5	3·2	2·4	5·0	5·3	3·1
	100·0	100·0	100·0	100·0	100·0	100·0	100·0

* Oil and tar excluded.

TABLE IV.

—	Works "E"—Much Trouble.			Works "A"—No Trouble.	
	Top Grid.	Middle Grid.	Bottom Grid.	Top Grid.	Bottom Grid.
Pounds S.A. per ton of coal carbonized	18½			28	
Character of oxide used	Artificial			Mostly Bog Ore.	
Spent oxide:—					
Character prior to revivification	Black	..	..	Black	Dark grey
Behaviour towards litmus	Neutral	Alkaline	Alkaline	Acid	Acid
Ferrous sulphate	None	None	None	Traces	Traces
"Moist" or "dry"	Moist	Moist	Moist	Moist	Dry
Moisture, per cent., per 100 parts	20·5	14·8	9·0	14·2	8·0
Oxide revivified at 30° C. and dried at 100° C. per 100 parts:—					
Sulphur soluble in CS_2*	60·80	57·60	52·70	41·50	44·30
,, as sulphocyanide	·25	·87	2·07	·20	·20
,, as sulphate, &c.	·60	1·10	2·00	2·20	1·90
,, other forms (by diff.) partly FeS_2	1·40	1·43	1·57	2·52	2·55
Total	63·05	61·00	58·34	46·42	48·95
Distribution of sulphur, per 100 parts of total sulphur:—					
Soluble in CS_2*	96·5	94·5	90·4	89·4	90·5
As sulphocyanide	·4	1·4	3 5	·4	·4
As sulphate, &c.	·9	1·8	3·4	4 7	3·9
Other forms (by diff.) partly FeS_2	2·2	2·3	2·7	5·5	5·2
Total	100·0	100·0	100·0	100·0	100·0
Total ammonia, calculated as $(NH_4)_2SO_4$, per 100 parts sulphur soluble in CS_2	7·7	13·5	24·3	2·2	2·3

* Oil and tar excluded.

bisulphide at works "E" is significant, and indicates that the missing ammonia is to be sought for in the oxide.

CONCLUSIONS.

Consideration of the facts stated above leads to the conclusion that great and avoidable loss of ammonia is taking place at most of the works where the direct process has been introduced. It is less easy to prescribe a remedy. Further experience is needed before the directions in which improvement is to be looked for can be indicated with certainty; but managers will be well advised to ensure that purifier temperature is not lowered by undue exposure of the boxes, that the moisture content of the oxide is carefully regulated, and that the crude gas enters the purifiers cool and dry and with a moderate and regulated amount of ammonia. The use of a washer fed with virgin liquor, placed between the acid bubbler and the purifiers, so as to cool the gases and equalize the supply of ammonia to the purifiers, has much to recommend it. The cooler the washer the more efficient should be its action. The samples of virgin liquor examined contain about 1 per cent. of free ammonia. Circulation of such liquor in the system should raise its strength, and return to the storage well a liquor very suitable for use on the virgin liquor still. Washers fed with virgin liquor are in successful operation at several direct process works.

It is important to remember that free ammonia readily volatilizes when ammoniacal liquor is freely exposed to the air. It is advisable, therefore, to cover the surface of liquor in all storage wells and supply tanks with a layer of crude mineral oil—say, ½-inch in thickness—and to convey liquor to the well by closed pipes sealed in the liquor.

The low working temperature of the purifiers might be corrected, in part, by the introduction of a steam-pipe for use in the colder weather; and revivifying floors should be covered and protected from driving rain.

It is interesting to note that hitherto the souring of oxide in the purifiers attached to plants for the manufacture of sulphate by the distillation process has chiefly been experienced in Scottish works, where the temperature of the purifiers is relatively low [see "Annual Report for 1913]." The importance of duly regulating the purifier temperature has long since been recognized in gas-works practice.

In the case of the larger works, the removal of hydrocyanic acid by scrubbing prior to the passage of the crude gas through

the acid bubbler is worth considering. At one large works where this is adopted, very beneficial results have followed—less ammonia has now to be bye-passed, and the purifiers work longer without change. The effect of placing a steam-pipe below the bottom grid is also under trial at these works; and the moisture content of the oxide is being reduced. The improved working is attributed to the combined effect of all these changes.

It is well to caution managers against instituting too many radical changes at the same time, and too abruptly. If a washer be introduced, the compartments should be successively charged with virgin liquor, with a suitable interval of time to enable the liquor and gas to come into equilibrium. Weak liquor takes time to come up to strength. The moisture content of oxide should not be rashly reduced—8 to 10 per cent. should be a suitable figure for a revivified oxide. Experience is needed in this process in the use of drier oxides. Steam-pipes should be cautiously used. The introduction of thermometers in the gas-mains entering and leaving the purifier system would afford valuable guidance. The temperature of the oxide on the various grids would be less easy to determine; but observations in this direction are to be made at two of the works named above—works "E" and "G."

In closing these remarks, I desire to express my thanks to Dr. Harold G. Colman for valued correspondence on the working of the direct process.

[Here there is an appendix, setting forth in detail the methods of analysis adopted.]

Sulphuric Acid Shortage.

The shortage of available sulphuric acid has led to a change in several works from production of sulphate to preparation of concentrated ammoniacal liquor, for which there is a large outlet. Endeavours have also been made to induce the use of nitre cake along with some sulphuric acid for the production of a sulphate containing about 20 per cent. of ammonia; but the adoption of this method has so far been very restricted. Efforts continue for the production of salts of ammonia without the use of sulphuric acid, either by utilizing the sulphur compounds present in crude coal gas or by utilizing sulphur from an independent source.

The extended operations in coke-oven works were associated with a further utilization of the coal gas produced for purposes of urban illumination, thus obviating increased production in gas-works to a corresponding extent.

The sulphuretted hydrogen given off during the treatment of gas liquor was disposed of by those methods hitherto in use. The heap form of purifier continues to increase in numbers, and to supplant from time to time the older form of walled purifier.

STORAGE OF AMMONIACAL LIQUOR.

Attention has been frequently called in the Technical Press to the loss sustained by ammoniacal liquor when stored under conditions which admit of free air circulation above the surface; and the subject found mention in the annual report of the Chief Inspector for 1910 and subsequent years. In the report for 1914 the suggestion was made that a layer of suitable oil covering the surface of the liquor when in the storage tank might prove to be effective in preventing loss of volatile ammonia; and it was further pointed out that oxidation changes which result in the formation of fixed salts of ammonia would at the same time be retarded, with an ultimate saving of lime or alkali in the fixed ammonia still. A suitable oil is one light enough to float on the liquor, and which will not evaporate readily. While a layer of great tenuity may be effective experimentally, this is not to be sought after in practice.

During the year 1915, opportunity was found to submit the matter to test. With the willing co-operation of the management and their staff, experiments were carried out at seven works. The results afford conclusive proof that a thin layer of crude paraffin or some other suitable oil—say, $\frac{1}{10}$ to $\frac{1}{4}$ inch in thickness—is effective in reducing oxidation changes and loss of volatile ammonia to minimal proportions throughout prolonged periods of exposure. Liquor stored under similar conditions without such protection is found to experience loss, which for the same liquor increases with a rise in temperature and the freedom with which air is allowed to circulate above the surface. In the case of one works only were anomalous results obtained. Here no oil was used to protect the liquor, which was stored in a horizontal boiler with an open manhole in the centre. In this case, the net total loss of ammonia per 100 parts of free ammonia present at the start did not exceed one-half of 1 per cent. in 55 days. It is significant, however, that slight traces of oil were visible on the surface of the liquor when this was viewed by reflected light in a porcelain dish. Possibly, this trace of oil formed a continuous layer on the surface of the liquor, and was sufficient to afford the necessary protection. The thinnest layer of oil actually experimented with was 2 mm. (= 0·08 inch) in thickness; and the loss of ammonia in this case did not exceed 0·3 per cent. in 70 days with free exposure to air. A thinner layer therefore might well prove to be equally efficacious in minimizing loss, provided the layer were continuous.

Works Tests.

The experiments were carried out under very varied conditions. Rectangular tanks, cylindrical boilers placed horizontally, and iron drums placed vertically were used. The volume of liquor stored varied from 17,600 gallons to 100 gallons; and the thickness of the protecting layer of oil from 1¼ inches to 0·08 inch. The maximum period of exposure in any one case was 92 days. Openings were left to afford the necessary circulation of air, with suitable overhead protection against rain. The liquor was sampled at the start and at appropriate intervals, and the free and fixed ammonia determined by distillation in the usual way. Where possible, a dipping tube was used to collect an average sample of the liquor. Where this was not available, the liquor was sampled at various depths—6 inches, 1 foot, 2 feet, &c.—below the surface, by means of a dipping bottle, and an average sample obtained by admixture. The analytical results are approximate only, as the volume of liquor taken for distillation did not, in general, exceed 10 c.c.; but for the purpose in hand a greater degree of accuracy was unnecessary.

The following figures are typical of the results obtained.

Works A. [Table V.].—1000 gallons of crude ammoniacal liquor were stored in the open air on the north side of a gasholder, to shield the tank from the direct rays of the sun. The tank was covered with a roofing of boards and felt, leaving a 1-inch space between the roof and the sides, thus permitting air to circulate freely over the surface of the liquor. Liquor in a similar tank was covered to a depth of 1¼ inches with a layer of crude paraffin oil. The loss of ammonia from the unprotected tank, corrected for evaporation of water, was 43·2 per cent. of the free ammonia originally present. From the protected liquor, the loss was 0·5 per cent. Contrary to expectation, the variation in the amount of fixed ammonia present was trifling; being within the limits of experimental error.

Works B. [Table VI.].—This experiment was arranged to test the protective effect of a layer of crude mineral oil of varying thickness. Mr. Young, the District Inspector for Scotland, had charge of the experiment, and sampled the liquors for analysis in my laboratory. Three iron benzol drums were employed, each holding about 90 gallons of liquor. The thickness of the layer of oil in drum A was 12 mms. (= 0·47 inch), in drum B 6 mm. (= 0·23 inch), and in drum C 2 mm. (= 0·08 inch); the thinnest layer of oil yielding a continuous surface with the particular oil used. The three drums were placed vertically in a roofed building, but were otherwise uncovered. No appreciable loss of ammonia was noticeable in 70 days. In a similar experiment, in which the layer of oil was omitted, the loss was over 30 per cent.

Table V.

Works A.—*Effect of Conditions of Storage on Ammoniacal Liquor.*

Date.	Number of Days' Storage.	No. 1. Tank. Liquor without Oil—1000 Gallons.						No. 2 Tank. 1¼ inches of Oil on Liquor—1000 Gallons.					
		Temperature when Sampled.		Ammonia by Distillation. Grammes per 100 c.c.			Total Loss per 100 Parts of Free Ammonia.	Temperature when Sampled.		Ammonia by Distillation. Grammes per 100 c.c.			Total Loss per 100 Parts of Free Ammonia.
		Top.	Bottom.	Free.	Fixed.	Total.		Top.	Bottom.	Free.	Fixed.	Total.	
		°C.	°C.					°C.	°C.				
May 25, 1915	Start	23	23	1·149	·323	1·472	..	23	23	1·149	·323	1·472	..
,, 26, ,,	1	23	22	1·118	·321	1·439	2·9	23	23	1·142	·326	1·468	..
,, 28, ,,	3	18	18	1·074	·329	1·403	6·0	18	18	1·143	·329	1·472	..
June 4, ,,	10	17	17	1 029	·326	1·355	10·2	17	17	1·138	·324	1·462	..
,, 11, ,,	17	17	17	·978	·332	1·310	14·1	17	17	1·118	·332	1·452	..
,, 18, ,,	24	15	15	·918	·336	1·254	19·0	15	15	1·134	·331	1·465	..
,, 25, ,,	31	17	16	·870	·336	1·206	23·1	17	16	1 127	·328	1·455	..
July 16, ,,	52	14	14	·784	·345	1·129	29·8	14	14	1·136	·330	1·466	..
Aug. 13, ,,	80	19	19	·707	·358	1·065	35·4	19	19	1·137	·327	1·464	0·5
Corrected for evaporation.	80	..	..	·647	·328	·975	43·2						

TABLE VI.

WORKS B.—*Effect of Varying Thicknesses of Oil as a Preventive of Loss of Ammonia.*

Date.	Number of Days' Storage.	Drum A. 12 mm. (= 0·47 inch) Layer of Mineral Oil.				Drum B. 6 mm. (= 0 23 inch) Layer of Mineral Oil.				Drum C. 2 mm. (= 0·08 inch) Layer of Mineral Oil.			
		Ammonia by Distillation. Grammes per 100 c.c.			Total Loss Per 100 Parts of Free Ammonia.	Ammonia by Distillation. Grammes per 100 c.c.			Total Loss Per 100 Parts of Free Ammonia	Ammonia by Distillation. Grammes per 100 c.c.			Total Loss Per 100 Parts of Free Ammonia.
		Free.	Fixed.	Total.		Free.	Fixed.	Total.		Free.	Fixed.	Total.	
Aug. 12 . .	Start	1·264	·206	1·470	..	1·264	·206	1·470	..	1·264	·206	1·470	..
Sept. 2. . .	21	1·262	·212	1·474	*Nil*	1·264	·208	1·472	*Nil*	1·264	·209	1·473	*Nil*
Oct. 21. . .	70	..	..	..	..	..	..	..	..	1·255	·211	1·466	0·3

TABLE VII.

WORKS C.—*Effect of Conditions of Storage of Ammoniacal Liquor.*

Date.	Number of Days' Storage.	Circular Tank. 17,600 Gallons of Liquor. 20 Feet Diam. by 10 Feet Deep at Sides, 11 Feet at Centre of Arch, with 9 Feet of Liquor. Gas-Tight Roof. Vent-Pipe for Air above Liquor Sealed in Carboy of Acid.			
		Ammonia by Distillation. Grammes Per 100 c.c.			Total Loss Per 100 Parts of Free Ammonia.
		Free.	Fixed.	Total.	
July 22, 1915 . .	Start	1·146	·487	1·633	..
Aug. 19, 1915 . .	28	1·125	·501	1·626	0·6

Analysis of Sulphuric Acid used in Carboy.

Before use	H_2SO_4 per 100 parts by weight . .	75
	Ammonia, gramme per 100 c.c. . .	0·004
After use	H_2SO_4 per 100 parts	75
	Ammonia, gramme per 100 c.c. . .	0·008

Works C. [Table VII.].—The tank at this works had a diameter of 20 feet, and held 17,600 gallons with 1 foot of free space between the surface of the liquor and the roof. The roof fitted gas-tight, and carrried a vent-pipe so arranged that, on expansion, air was driven through an acid-seal, and on contraction air entered through a water-seal. The arrangement was one designed by the manager to guard against loss of ammonia, before the protective effect of oil had been brought to his notice. Analysis of the liquor stored and of the acid in the catch-vessel, before and after the experiment, indicates that the amount of ammonia volatilized from the liquor and entering the acid was small. A layer of crude paraffin oil would have served the purpose equally well, and needed no attention.

ADVANTAGE OF COVERING-IN SEAL-POTS AND SYPHONS.

I desire also to draw the attention of managers to the advantage of covering-in seal-pots and syphons, where conditions are unsuitable for the use of oil as a protective layer, but where loss of ammonia is by no means negligible. At one works where special precautions were taken by the manager to guard against secondary losses of this kind, it was claimed that very substantial saving of ammonia had been effected by boarding-in the various syphons where liquor was in motion and exposed to the air.

GAS ENGINEER'S REMARKS ON EXPERIMENTS.

In conclusion, I desire to express my sincere thanks to the managers who provided the necessary tanks for the experiments, and to the members of their staffs who sampled the liquors with so much care, and despatched them for analysis.

It is permissible, perhaps, to quote the remarks of the engineer and manager of an important gas-works where one set of experiments was carried out in the summer of 1915, with gratifying results: "With reference to our recent correspondence regarding the protection of ammoniacal liquor by a coating of oil, I beg to say that we have adopted your suggestion at these works, with beneficial results. It is impossible to give any actual figures at the moment; but it is so far satisfactory that there is an entire absence of smell of escaping ammonia in the neighbourhood of the storage tanks." At a later date, the works chemist stated that 10,000 gallons of ammoniacal liquor of 85 oz. strength had been stored for three weeks in an uncovered concrete tank (in a building) freely exposed to the air, under a layer of oil ⅛ inch thick, without loss of ammonia.

LENGTH OF PIPES DELIVERING AMMONIACAL LIQUOR INTO WELLS.

It is still in too many works the practice to omit to lengthen pipes delivering ammonia liquor into storage wells downwards far enough to avoid a fall through the air of the entering liquor. This is a most effective method for dispersing ammonia, and is specially prejudicial if oil be used as a protective layer, as not only is ammonia lost before the liquor reaches protection, but the oil and liquor are agitated together. In this way, a union of oil and tar is induced. When the product becomes heavier than the liquor, it will sink to the bottom, and no longer afford protection. Another practice which is open to criticism as regards loss of ammonia is the construction of storage tanks for liquor as roofs to buildings or in other exposed positions. Temperature is an important factor influencing loss of ammonia from its solutions; and when the sun's power has full opportunity, it accentuates losses of ammonia. As this during the summer season that the longest periods of liquor storage occur, this is the more worthy of consideration. The whitewashing of outer surfaces and a protective layer of oil should effect much benefit in such cases, while removing a possible source of annoyance to the vicinity.

INFLUENCE OF IRON PYRITES ON THE OXIDATION OF COAL.

This is the subject of a paper by T. J. Drakeley, in the current issue of the Chemical Society's "Journal." After some little discussion and criticism of previous work on the subject, the author remarks that probably moisture plays an important part in, and accelerates, the oxidation of the coal. It is considered, however, that an excessive amount of water retards spontaneous combustion in two ways. First, the water enters the pores of the coal, and so renders it less pervious to the air; and, secondly, the temperature is kept low by evaporation. A moist atmosphere is practically essential for the oxidation of the iron pyrites; and the author judges that it would also be favourable for the oxidation of the coal.

In order to ascertain the influence of iron pyrites on the oxidation of coal to carbonic acid, the oxidation products of pyrites, coal, artificial mixture of pyrites and coal, ferrous sulphate, mixture of ferrous sulphate and coal, and mixture of sulphuric acid and coal, were studied. The coal was a selected sample of "King" coal from Pemberton Colliery, Wigan, containing: Carbon, 76·020 per cent.; hydrogen, 5·076 per cent.; nitrogen, 1·364 per cent.; sulphur, 1·358 per cent.; ash, 4·750 per cent.; oxygen, &c., by difference, 11·432 per cent. It gave, on approximate analysis: Coke, 62·99 per cent.; ash, 4·75 per cent.; and moisture, 1·329 per cent. In this seam of coal, no case of spontaneous combustion has ever occurred.

From experiments in which the materials were subjected to moist air, it was found that, in the absence of carbonaceous matter, pyrites oxidizes to ferric sulphate. No oxidation of the iron and sulphur which occur naturally in the coal in small quantities, could be detected. Mixture of the pyrites with coal causes the absorption of oxygen to be more vigorous at first—the pyrites oxidizing to ferrous, and then to ferric, sulphate. Sulphuric acid is a deterrent to the oxidation of coal, probably by reason of the acid—wet coal being less impervious to air, with consequent slower absorption.

The sum-total of the experiments appears to be that iron pyrites has a minor effect; but because coals which cannot be regarded as pyritic are among those most liable to spontaneous ignition, it cannot be inferred that its presence may be ignored. Pyrites disseminated throughout the coal in microscopic particles obviously acts more effectively than larger quantities of nodules.

Society of British Gas Industries.—The general business meeting of the Society will take place at the Holborn Restaurant, W.C., on Wednesday, the 11th prox., at 3 o'clock, when a short report on the work of the Society during the past six months will be given by the Chairman of the Council (Mr. H. M. Thornton, J.P., M.Inst.Mech.E.). This will be followed by a discussion. At the close of the meeting, there will be afternoon tea, by invitation of the Chairman of the Council. In connection with the programme, the Secretary (Mr. A. L. Griffith) intimates that, owing to the war, the Council have considered that it would be the wish of the members generally that the usual dinner should on this occasion be dispensed with.

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ADVANTAGES OF GAS-ENGINES AS COMPARED WITH STEAM-ENGINES.

Writing in the "Gas Magazine" [U.S.A.] Mr. W. Julius Rogers is enthusiastic on this subject, and states that although coal merchants and other interested parties have asserted that the gas-engine is unreliable, his experience in operating numerous power plants containing gas-engines ranging from 10 to 1350 H.P. is that they are more dependable, and require less attention, than steam-driven plants of similar size, and that the chances of failure or breakdown are much less, seeing that the use of the gas-engine enables the steam-boiler, feed pumps, superheater, feed-water softening apparatus, and other trouble-making devices, to be dispensed with.

In respect to economy, reliability, and efficiency, there is nothing on the market that will successfully compete with the modern gas-engine, fitted with double ignition (battery and high tension magneto system). It has a speed variation of only 2 per cent. between full load and no load, which is equal if not superior to that of a high-class steam unit, and is particularly an advantage in connection with all electrical purposes. The average steam-engine delivers less than 5 per cent. of the total energy contained in the coal in the form of useful work; but the gas-engine accounts for more than 25 per cent. of the calorific value of the gas that it consumes.

Take, as an illustration, a typical steam plant of 300 H.P., comprising horizontal tubular boiler, standard feed pumps, and an automatic high-speed engine, which in practice is found to require 30 lbs. of steam per horse-power hour. Assuming the calorific value of the coal to be 12,000 B.Th.U. per pound, each pound of coal consumed in the boiler furnace will evaporate 5 lbs. of water, and the engine will consume 30 lbs. of coal per horse-power-hour. As 6 lbs. of coal are burnt, generating $6 \times 12{,}000 = 72{,}000$ B.Th.U. per horse-power-hour, equivalent to a useful effect of $\frac{33{,}000 \times 60}{778} = 2545$ B.Th.U., or about $3\frac{1}{2}$ per cent. of the total heat supplied, it follows that $96\frac{1}{2}$ per cent. of the money expended on coal is lost by incomplete combustion, escape at the top of the smoke-stack, radiation and convection of heat from steam-pipes, condensation in the cylinder, and other losses peculiar to the engine. These obtain when the plant receives competent treatment and proper attention, and, in addition, there may be further losses due to negligent handling, scaling or sooting of the boiler, unadjusted valves, leaky pistons, &c.

A standard make of modern 300 H.P. gas-engine is guaranteed to operate on a supply of 10 cubic feet of 1000 B.Th.U. per cubic foot of natural gas per horse-power-hour, and in everyday working has been found to run on 9·75 cubic feet of 960 B.Th.U. gas, which meant the delivery to the engine of 9360 B.Th.U. The heat equivalent of one horse-power-hour has been shown to be 2545 B.Th.U.; and this quantity, divided by 9360, gives 27 per cent. of the energy in the fuel delivered to the engine in the form of useful work, as compared with $3\frac{1}{2}$ per cent. or less from the steam-driven plant. This estimate claims that one horse-power-hour can be furnished either by the combustion of 30 lbs. of coal or of $9\frac{3}{4}$ cubic feet of natural gas. With coal delivered on the site at 30s. per ton, to which must be added the cost of handling —say, 2s. 6d. per ton—the cost for coal per horse-power-hour will be $5\frac{1}{4}$d., and natural gas at 44·7d. per 1000 cubic feet would be the equivalent in price.

Comparing these figures with the conditions usual in this country, a modern-type expansion engine can be run on 11 lbs. of steam per horse-power-hour, and the evaporative power of average steam coal may be taken as 8 lbs., which means a consumption of only $1\frac{3}{8}$ lbs. of coal per horse-power-hour. Gas-engines require about 15 cubic feet of ordinary town gas per horse-power-hour, and the equivalent price for gas would be nearly 8s. per 1000 cubic feet.

At the current prices of coal and coke, it would appear possible to make out a good case for gas-engines, as compared with steam-engines; and that, when gas undertakings are again in a position to resume a progressive and active policy in the sales department, the advantages of the gas-engine will be worthy of a larger amount of consideration than they have received in the past.

THE COMMERCIAL END OF THE GAS BUSINESS IN CANADA.

In opening the proceedings of the Canadian Gas Association, held at Quebec on Aug. 16, Mr. R. A. Wallace (the President) expressed hopeful views as to the future of the gas industry. The necessities of the military situation had given some impetus to the development of more efficient methods and appliances for the use of gas as a fuel in the manufacturing arts, and an increased activity of research in fields hitherto but partially explored, that would tend to enhance the value of their residual products. The upward tendency on the costs of all supplies was a cause for uneasiness, and the public must give consideration at least to less frequent and insistent demands for reduction in the price of gas.

One of the most important questions to those responsible for the care and operation of gas-works was that of public policy, and of providing adequate measures for the maintenance of harmonious relations between themselves and their customers. The increasing importance and value of the services rendered seemed to have stirred up a spirit of antagonism in the public mind, and corporate bodies, organized for the purpose of serving the public, are each year becoming objects of agitation and clamour to a greater extent. There was a general demand for more stringent regulations; and a well-founded rumour had been circulated to the effect that attempts had been made to have the inspection and regulation of these properties transferred from the federal and provincial to the municipal authorities. The position indicated the wisdom of keeping in close touch with the situation, and afforded material for much consideration to those interested in the expansion of the gas industry. A study of the proceedings of kindred Associations, in respect to differences arising in the course of dealing with the public, revealed the existence of a very strong tendency towards centralization and combined activity. But in Canada, it was a question whether all of those who were responsible for the care of the gas interests fully appreciated the benefits to be derived from a union of forces; otherwise there would be a larger membership of the Association. The gas industry had not by any means reached the zenith of its possibilities; and notwithstanding efforts put forward by progressive companies, and the commercial strides generally made in late years, they were not all entirely in accord with the people they served.

A better understanding between producer and consumer seemed to be the key-note of future progress, and was apparently quite practicable. Each party must understand that the other has rights to be respected as well as duties to be performed. A habit of viewing matters of difference in a broader spirit, and with regard to the opposite interest, rather than solely from our own standpoint, indicated the direction in which lay the way out of these difficulties. There should be a clear understanding of the common interests which concerned both themselves and their customers, and any traditional methods or practices that impeded advancement should be eliminated. He urged on his Canadian business associates the desirability of closer co-operation of a stronger and more vigorous amalgamation, to the end of more efficiency to bring about mutual understanding, that would even justify them in the judgment of their opponents.

It was useful and instructive to follow the progress of the gas industry in other countries; but there were always local circumstances that must have considerable influence on questions of common interest. Consequently, in Canada they had their own peculiar questions to deal with, and their own precedents to establish. To do this successfully, they must all endeavour to keep in intimate contact with co-workers, and avail themselves of every method and opportunity of bringing about a keeneer appreciation of their sincerity of purpose, and of showing that they exercised their privileges with discretion. In proportion as each one contributed to the success of the industry, he may expect to share in its increased prosperity.

The two papers read at the meeting—"Gas Lighting Service," by Mr. J. P. Conroy, and "Is the Industrial Fuel Business Worth While?" by Mr. H. E. G. Watson, and illustrated with lantern views—met with a full discussion on the lines indicated in the presidential address.

An Adiabatic Calorimeter.

The "Journal of the Society of Chemical Industry" abstracts a paper on this subject contributed to the American Chemical Society by Mr. F. Daniels. The adiabatic calorimeter described obviates the necessity of any cooling correction. The inner can, containing the thermometer and the source of heat, is filled with water, and is set upon glass supports in a slightly larger vessel; and the whole is closed tightly by a ground-in brass cover. This arrangement is supported on glass rods in a large double-walled copper vessel filled with water, and provided with a stirrer. Immersed in the water of the inner calorimeter and this outer water-jacket are the junctions of a thermocouple, so that temperature differences of 0·01° C. can be immediately detected by means of a mirror galvanometer. In use, the radiation or conduction from the calorimeter proper is prevented by maintaining the outer water-jacket at precisely the same temperature by hand manipulation of an electric heating circuit, the terminals of which are connected with the inner wall of the outer vessel and the outer wall of the inner vessel respectively, so that the current actually traverses the water-jacket, and the lag attendant on the use of resistance spirals is obviated. An automatic control by means of a selenium cell and a relay is also described which for a slow rise of temperature in the calorimeter will keep the determination adiabatic to within 0·02° to 0·03° C. without attention.

Explosibility of Acetylene.—This subject was dealt with in a paper by Messrs. Burrell and Oberfell, issued by the Bureau of Mines, Washington. The authors stated that their experiments showed that the smallest proportion of acetylene capable of propagating flame in a mixture of acetylene and air was 2·53 per cent. The largest proportion of acetylene capable of propagating flame in a mixture of acetylene and air was found to be about 73 per cent. Acetylene not mixed with air is explosive under a pressure of three to five atmospheres when an electric spark is passed through and when a platinum spiral is heated in it. The danger connected with the handling of calcium carbide in a mine is remote, the authors contend, if reasonable care is observed in handling.

PLANS AND RECORDS OF WATER DISTRIBUTION SYSTEMS.

By WILLIAM P. WALKER, Inspector of Mains, &c., London Hydraulic Power Company.

[From a Paper read before the Institution of Water Engineers.]

The keeping of correct plans and records of underground mains is very necessary for the successful management of water-works distribution systems; yet it is exceptional to find this important work properly done. Some undertakings have no records at all kept, and are thus almost entirely dependent upon the memory of the turncock, foreman, or other official in charge of the mains for information in connection therewith—a state of affairs which is certain to lead to confusion at some time or other. In such circumstances, time and money are often wasted in opening-up roads or paths to locate the mains or service-connections, which would be entirely avoided if correct records of the mains had been systematically kept.

When main or service laying is in progress, the fullest information regarding the same should be carefully noted by the foreman or the inspector in charge of the work, in a notebook kept specially for the purpose. Scraps of paper should never be used, owing to the ease with which they may be lost. The information should include the date when the work is carried out, the internal diameter and length of every pipe laid, and the depth and position of the main or service. It may also be an advantage to note the position of any other pipes or electric cables crossing the water-mains. The position of the main may be conveniently measured from the nearest kerb-line.

To locate the position of valves, plugged branches, and other special fittings, at least two measurements should be taken from permanent objects, such as kerb lines, centres of doorways, or corners of buildings. Such measurements are especially useful in the case of valves, because these are sometimes inadvertently paved over when roads are being re-made or repaired, and thus become inaccessible as well as difficult of location.

MAINS RECORD REGISTER.

A mains record register should be compiled from the information contained in the foreman's notebook previously described, and should be kept at the manager's office for reference. A convenient size for the book is 8 inches by 13 inches; the pages being ruled and headed as in the example. It should be provided with an alphabetical index in which the names of the streets or roads are entered. The information in the register is recorded on a plan. The folio number at the top of the register refers to the record of the 6-inch main in High Street to which the 3-inch main is connected.

It will be seen that a record is kept of every pipe laid, and the length of each pipe is also given. This is found exceedingly useful in the event of leakages occurring at the joints of mains, owing to the facility with which joints may be found by measurement from the nearest valves or other fittings which have their positions recorded—thus saving any unnecessary excavation. Records of the services may be kept in similar books. These should show the length of the service from the stopcock to the main, and would indicate the position of the main at that point. These registers may be books on the loose-leaf system, which admit of the insertion of explanatory tracings or sketches of intricate crossings, also of the addition of new pages when alterations or extensions have been made to the original mains.

← 8 inches →

← 8 inches. →

Off 6 in. × 3 in. branch North, Folio 20, Volume I. Mains Register.

Date.	Street.	Pipes.		Depth.	Position.	Remarks.
1915.						
Sept. 1	Weston Street working North	1	3 in. × 2 ft.	3 ft. 2 in.	..	..
		1	3 in. S.V.	..	4 ft. from line E kerb of Weston Street	3 in. valve 4 ft. S. of line of N. kerb in High Street
		15	3 in. × 9 ft.	..	..	Service off 4th pipe to No. 4, Weston Street
		1	3 in. × 6 ft.	..	..	..
		1	3 in. × 3 in. T (West)	..	..	3 ft. 6 in. N. of line of S. kerb Station Street
		4	3 in. × 9 ft.	..	..	Off branch of Tee 3 in. main along Station Street, Vol. 1, Folio 36
		1	3 in. × 3 in. T (East)	..	..	1 ft. 6 in. S. of centre doorway, N. 20. Off branch of Tee supply to hydrant. Hydrant Register I. Folio 6
		3	3 in. × 9 ft.	..	..	..
		2	⅛ bends (W and straight)	..	..	..
		4	3 in. × 9 ft.	..	4 ft. 10 in. from E. kerb	← Centre of book.]

PLANS OF MAINS.

The plans of mains should be plotted on large-scale Ordnance maps, from the detailed information in the mains register. Pipe-lines may be indicated by firm blue lines. No useful purpose will be served by plotting every individual pipe on the plan, but special pieces, such as tees, valves, and bends, should be shown, and their positions accurately plotted to scale. Valves can be denoted by red circles and hydrants by blue circles, and exceptional depths of the main may be noted in red figures, also the radii of bends in the mains. It is of the greatest importance that the plans should be kept thoroughly up-to-date; and whenever alterations are made in the mains or street-lines, the new positions should be accurately measured, and the plans be altered accordingly. The plans should be numbered, and may be kept flat in drawers or folded into four and mounted in stiff board covers, the latter method economizing space for storage. For the sake of durability, they should be mounted upon linen, or preferably on three-ply board which, being stiff, not only protects them but enables them to be handled with more ease. These plans, used in conjunction with the records register, will give all the necessary information for the location of any particular pipe. If desired, the premises occupied by each consumer may be coloured or cross-hatched on the Ordnance maps, and its number in the Service Register noted thereon.

VALVE-LOCATION BOOKS.

On occasions when a new turncock or foreman is placed in charge of any given portion of a distribution system, unless he has served under his predecessor, some time may elapse, and a great deal of inconvenience be caused, before he has learned the positions and uses of the valves controlling his district. In such a case, a valve-location book, which consists of a sectional skeleton plan of the mains in pocket book form, will prove invaluable.

In connection with this book a skeleton-plan of the whole distribution system—showing mains, valves, and hydrants—will be found useful. This may be divided into districts, and each district subdivided into sections comprising three or four streets in each section. Small skeleton plans of each section should be prepared, showing the valves controlling the section. The plan of each section is drawn on one page, and on the facing page the diameter and position of each valve is indicated, as in the following example:

Main Valves, Branch Valves, and Hydrants.

MAIN VALVES.

No.	Size.	Street.	Remarks.
1	3 in.	Well Street .	3 ft. 2 in. W. of E. kerb, Market Street. 2 ft. 9 in. S. of line N. kerb, Well Street.
2	3 in.	Well Street .	4 ft. E. of W. kerb, Brook Street, 2 ft. 9 in. S. of line N. kerb, Well Street.
3	3 in.	Market Street.	Opposite centre door No. 101, 3 ft. 3 in. W. of E. kerb, Market Street.
4	3 in.	Sale Street .	4 ft. 6 in. S. of N. kerb, Sale Street, 1 ft. 4 in. W. of E. kerb, Market Street.
5	3 in.	Brook Street .	11 ft. S. of centre of door 42, Brook Street, 4 ft. E. of W. kerb.
6	3 in.	Brook Street .	6 ft. N. of line S. kerb, Sale Street, 4 ft. E. of W. kerb, Brook Street.

BRANCH VALVES.

A	3 in.	Bear Lane. .	In line of kerb, Market Street, 2 ft. S. of N. kerb, Bear Lane.
B	3 in.	Trinity Place .	1 ft. 6 in. N. of S. kerb, Trinity Place, 3 ft. E. of W. kerb, Brook Street.

HYDRANTS.

1	3 in.	Market Street.	On W. footway, 3 ft. S. of centre of doorway, 24, Market Street.
2	3 in.	Sale Street .	On N. footway, opposite centre doorway of 16, Sale Street.
3	3 in.	Brook Street .	4 ft. E. of W. kerb, 2 ft. 9 in. S. of centre of doorway of No. 1, Brook Street.
4	3 in.	Trinity Place .	On E. footway, 4 ft. S. of centre of gateway of No. 4, Trinity Place.
5	3 in.	Trinity Place .	3 ft. S. of N. kerb, Trinity Place, in line with dividing wall of Nos. 14 and 15.

All the valves controlling dead-ends of mains are denoted on the plan by means of letters, while valves controlling circuit or through mains are numbered. The figures enclosed by circles at the ends of the mains in the sectional plans denote the pages in the valve-location book, where the adjoining sections may be found. The names of the streets in the section are shown above the plan; and the book is provided with a suitable index. A valve-location book of this character should be provided for the turncock or foreman in charge of each district, as, by its aid, he would be in a position to take charge of a new district at short

notice, and could be moved from one district to another without inconvenience. Incidentally, this system does away with the necessity for indicator-plates to show the location of valves.

The system of keeping records above described was adopted by the London Hydraulic Power Company at its inception, and has been applied with great success to a system of upwards of 180 miles of distribution mains. The author can appreciate the value of the system, having now been engaged with the Company for a number of years.

DISCUSSION.

The PRESIDENT (Mr. F. W. M'Cullough, of Belfast) said the members were much obliged to Mr. Walker for his interesting paper. The Secretary (Mr. Percy Griffith) would read two communications he had received from absent members.

Mr. F. STORR (Wrexham), in the course of a prepared communication, said with the views expressed in the first paragraph of the paper, most engineers responsible for the distribution of water would heartily assent; but, for the credit of water engineers, it was to be hoped that the keeping of records and plans of underground works was not so exceptional as the author inferred. The chief point was to establish such a system which, while fulfilling the purpose intended, was not too complicated or cumbersome in carrying out. The introduction of books and records, in addition to sketches, diagrams, detail plans, and Ordnance maps, while permissible where an unlimited staff was available, was not quite so convenient where the undertaking was of a more moderate character than was the London Hydraulic Power Company. In connection with a company supplying a large rural district, some 14 miles long by 7 miles wide, with numerous villages and hamlets, served by mains (approximating 100 miles in all), such a system as indicated in the paper was tried some years ago, but was not found to be satisfactory. The method now adopted was as follows: The whole of the trunk and distributing mains were marked in skeleton on the 1-inch Ordnance map, and as there were two zones of pressure, the high-level mains were indicated by a red full line, and the low-level ones by a blue full line. This skeleton plan showed at a glance the whole of the distribution system; and the next step was to divide the area into a convenient number of districts, each one being named and coloured with a distinctive colour. For the purpose of locating the various mains, valves, hydrants, &c., a 25-inch map was adopted; the valves being marked by a short cross line in blue, the hydrants by a small red circle, and air-valves by a small blue circle. As it was impossible on so small a scale to plot with any degree of accuracy the relative positions of the various valves, hydrants, &c., the following procedure was adopted: As the mains were being laid, the usual measurements were, of course, taken. The positions were then marked as near as possible on the 25-inch map, and round each valve or other important point a small circle was made in the same colour as the district bore on the 1-inch map. Within this circle was a number in the same colour—each important point having its own consecutive number. These numbers were also entered on location cards which were filed in consecutive order. As all the dimensions were figured, it was not necessary to plot to scale. The top of the card bore the name of the district; and the number was at the top right-hand corner. No measurements were taken from kerb-stones, especially in new localities, as these were so often altered—notably at street corners. The division lines of buildings, and the intersection of the lines of projection of buildings (as adopted by the Ordnance surveyors) were far preferable as points of measurement.

Mr. HERBERT HALL (Montrose), in a communication, said the subject of Mr. Walker's paper touched on a sin of omission that would be found, could careful inquiry be made, common in water-works management of the smaller class. The difficulties arising from a proper record induced him some twenty years since to provide a remedy, and the method adopted was offered as one that might lead to some recognized system being used for the location of underground works. Plans of water-mains, beyond showing the positions of valves, and the general lay-out of a system, were of little service for giving details. In the 10-feet scale Ordnance maps, 1 inch represented roughly 41 feet; and there might be anything from three to twelve services in this distance that were difficult to locate correctly on a map of convenient size. In the method submitted by him, each main was treated as a survey line, and the branches upon either side were recorded as offsets upon a specially ruled page for recording the various measurements. The central column of a page was the line of a main; and on it were only shown the valves and hydrants. The former were indicated by a lozenge; the latter, by circles. The columns on the right and left showed the service-pipes and other branches. Each valve was made a zero point, from which a fresh set of measurements started. The left-hand (facing) page was plain ruled for any remarks or sketches. Since the compilation of the book, they had had no trouble in locating any branch or connection. The centre line of the main was clearly indicated in the sheet by the hydrant or valve covers, and in practice any branch required was found by the difference of measurement from the nearest one at hand. When a new main was laid, the measurements were revised, and transferred to a new page; the former one being marked "cancelled." With this method, the plans were superseded. The records gave all particulars, which would be next to impossible on a plan. There was no difficulty in locating any hydrant, as they and the valves had indicator plates. He did not agree with the suggestion that they could be dispensed with, as they were invaluable for fire extinguishing purposes, and showed the fire brigade the nearest point at which to obtain water.

Mr. E. C. HAARER, Engineer to the London Hydraulic Power Company, said there was very little to add to the paper. It showed a complete and modern method of plotting-out the mains in a city. In London, during the whole period of over thirty years, they had never found the least difficulty in locating any mains, or, when suffering from a leak or break, their inspectors had been able to isolate any particular section in very quick time. He believed the average time in locating and shutting-down any particular service had been only twenty minutes—that was, from headquarters.

Mr. C. H. ROBERTS (Aberdeen) said he hoped there were very few water undertakings that did not keep records. In the Water-Works Clauses Act, there was a section that made it obligatory on a water authority to keep records of their mains in streets and roads, and, when required, they had to allow the records to be inspected.

Mr. C. CLEMESHA SMITH (Wakefield) questioned whether the keeping of records was obligatory apart from the question of mines. If anybody wanted to burrow under water-mains, the water authority had no redress unless records of the mains had been kept. The obligation was not a general one.

Mr. A. B. E. BLACKBURN (Sunderland) remarked that the obligation was that the plans should be deposited with the clerk of the peace. He did not suppose there were many water engineers in the Institution who did not keep some sort of record of their mains. The method described in the paper was somewhat elaborate—it was a method of perfection. Some of them might be satisfied with a little less than the author suggested. He knew that, in the case of some water authorities, in the distant past, it was left to old officials to remember where certain valves and hydrants were fixed; and there was the liability of disastrous results if the information contained in the heads of these particular officials was not put on record.

Mr. D. HALTON THOMSON, M.A. (Portsmouth), said those who had to deal with old-established systems had often sighed many times for information of mains laid in different parts. The only point of difference likely to arise was as to how far a record system could be carried before its advantages were outweighed by the burden of its maintenance. In his opinion, the system advocated by the author was a counsel of perfection. He told them it was based on the system adopted by the London Hydraulic Power Company. No doubt the system was of the utmost utility in the very congested parts of London, where the Company's mains were exclusively laid, and having regard to the excessive pressures. The Company guaranteed a pressure of 700 lbs. per square inch, he believed; and therefore great care must be exercised in regard to every detail—such as joints, &c. In ordinary water-works systems, however, the relation of the length of mains in congested districts to the total length of the whole system was really a very small one; and a much simpler method of record would suffice. He thought the plan method should be the primary means of record. The advantages were that—except for occasional notes recording unusual depths—only a scale was needed to obtain all the information required. The plan system also obviated all detailed lists of pipes, valves, and hydrants, except, of course, for storing purposes. Another advantage of the plan was that one obtained a mental picture of the distribution system. Under the author's method, the positions of valves or hydrants were recorded no less than three times. On the plan system, all these were recorded by a single short stroke or circle on the main, with a figure at the side denoting the size. He thought that for urban areas, where they had half-a-dozen mains lying side by side in one street, and where there were complicated connections, a $\frac{1}{500}$th scale plan—roughly 40 feet to the inch—on which the names could be plotted-out without crowding, was advisable. Of course, the disadvantage of large plans was, in the first place, that they were unwieldy, and not easily carried about; and consequently one could not get a bird's eye view of the system. In Portsmouth, they prepared a pipe plan of the borough in skeleton form. The pipes themselves were shown, but not the streets; the names of the streets being written along the pipes, together with the sizes of the mains. On these pipes all the valves were shown by short thick strokes across them. In the Water-Works Clauses Act, 1847, a water authority was not permitted to lay a main along a private road without the consent of the owners or occupiers. In their district, they had a dispute on the point some time ago. When new roads were opened up, they were, in the first place, private roads before being made over to the public. They had now introduced the system of asking the occupier or owner to sign an application form on a plan. These applications were numbered and filed; and the length of pipe was marked on the large-scale plan. In this way, they had a record of every application for a service main; and should it happen that the road was not made over to the public, evidence could always be produced of an application having been made for a main. A road-opening book was kept, in which was recorded the date, the name of the street, and the size and position of a main when exposed. By this means, the large-scale plan was checked. This was found especially useful in the older parts of the town, where in the early days proper records were not kept.

The PRESIDENT observed that in Belfast they not only recorded on plans the numerous mains they had in the city, but on index sheets as well. Some years ago, he also introduced, for the turn-cocks, the important convenience of putting in their books the

sizes of mains, with the valves, hydrants, &c.; so that a turncock could go to any particular place, and know exactly where to find a valve or hydrant.

Mr. WALKER thanked the members for the information given in the discussion, which, he said, more than repaid him for the little trouble taken in preparing the paper. With regard to large-scale maps, they were cumbersome; and they could not be carried about when inspections were being made or other cause required. He preferred diagrammatic sketches of the whole system contained in one book. Then one had only to turn up the section wanted.

CORRESPONDENCE.

[*We are not responsible for opinions expressed by Correspondents.*]

The Future of Low-Temperature Carbonization.

SIR,—Please accept my thanks for inserting the "Visionary's" letter [see *ante*, p. 518].

I am rather puzzled why you adopt the views you do, and the inimical attitude you take towards low-temperature carbonization. As regards "Coalite," I can quite understand; but because this ill-conceived venture proved such a failure, there is no reason to condemn off-hand the question of low-temperature carbonization generally.

This "Coalite" fiasco has done *bonâ fide* low-temperature carbonization much harm. It has put it back many years; and I do not see that the offshoot the "Barnsley Smokeless Fuel Company" will do any better, because from what I gather they are departing from low temperature by constructing brick ovens, and are seeking to obtain benzol and toluol, which are distinctly high-temperature products.

As chemist, engineer, and a thinking man, I have been impressed for some years past by our great waste of coal; and having been a denizen for many years of comparatively smokeless cities, I have been using my knowledge and efforts to see how our own cities can be relieved of what are really calamitous conditions—due to burning bituminous coal; and no one appreciates more than myself how well the gas companies are contributing to this by the supply of gaseous fuel. I think it the duty of every man with any knowledge of the coal question generally to aid to the extent of his power in helping to solve this problem; and the question is how can we possibly conserve the constituents of the coal, so as to render them economically and nationally useful?

As a gas engineer in charge of a big undertaking, and saturated for a lifetime with ordinary gas-works tradition, I had no time to view the perspective of any system which would hinder me making dividends for shareholders. If coal had to be wasted to make these dividends, so much the worse for the coal and the nation; and this I think you will find is the fundamental idea actuating every gas engineer who is harnessed to a company or corporation. I have always instinctively felt that to approach any gas authority to consider any departure from their hidebound traditions, would be simply waste of time.

But, after all, I am first and last a gas engineer, and I have viewed with anxiety, not only in this country but in others in which I have worked, the terrible advance and inroads which electricity is making into the gas business. One cannot shut one's eyes to this fact; and I say and repeat over and over again that it is my firm conviction that the supply of illuminating gas has reached its zenith and will gradually give place to electric lighting.

I have foreseen this in almost every city I have visited. If it were not so, why do some of our own corporate bodies—Tottenham, Herne Bay, and others, seek to become purveyors of electricity? The Directors of these undertakings (if not already too late) are taking time by the forelock and are meeting the competitor in the gate.

I have sought, and sought deeply, to see how the existing gas-works methods can be brought into harmony with the coming conditions. It is not a question of seeking a problem inimical to gas-works interests, but of helping them in some way to meet the coming giant. And I venture to think that a gas engineer is more qualified to do this than any outside person.

You know that I am practically the only *bonâ fide* gas engineer who has tried to tackle the problem. I have worked hard—perhaps harder than I ever worked before; and I have put my hand deeply into my pocket. I know I am fighting an uphill fight; but I am tenacious, and feel that not only am I on good ground, but that I am doing a duty in endeavouring to prevent the wicked waste of coal and its bye-products.

A man lately asked me how I liked the "slating" the "JOURNAL" gave me. I said it was like water on a duck's back. But I added that it seemed rather hard that a man who was spending time (years) and money to assist in working out a national problem should be badgered, rather than given the encouragement which a newspaper of the standing of the "JOURNAL" should in all fairness give. Instead of slating me, as my friend put it, why not go into the matter impartially and with an open mind, and seek knowledge which would add to the useful information you give to your readers generally?

I bring all my trained knowledge to bear. I am supported in my views by men of science—Dr. Galloway, Dr. Mollwo Perkin, Dr. Dunstan (East Ham Technical College), Dr. Dunn, the City Analyst of Newcastle, Professor Bone, and others. These men believe the line is a right one, or I should not have secured *bonâ fide* reports from certain of them, which have enabled me to secure three contracts for works on a large scale—one for the "Forest of Dean" Colliery, one for Natal, and one for the Spanish Government (Barcelona).

I am writing you an article on the question, and I should like to embody in it particulars of a great scheme based on carbonizing cannel, on which we have made some exhaustive trials. The producer gas portion has been verified by the Power Gas Corporation and the electrical figures by the British Westinghouse Company.

Please pardon me for inflicting this long letter on your readers; but I should so like the "JOURNAL" to treat this question in a broader manner than has hitherto been the case, and so give the whole question the careful consideration it surely demands.

19, *Queen Anne's Chambers, S.W.*, *Sept.* 16, 1916. F. D. MARSHALL.

[It is not proposed to "badger" or "slate" Mr. Marshall over the foregoing letter. It is merely in the nature of an explanation, leaning to the personal rather than to the technical side of the matter under discussion. In "The Times Engineering Supplement" article (upon which comment was made in the "JOURNAL" for Sept. 5, p. 429), our friend was obviously steering a middle course, with the view of not wounding the feelings of his numerous gas colleagues by directly foreshadowing the total extinction of their industry, while at the same time annulling the kindly act by showing on paper their electrical rivals how, by adopting the low-temperature process of carbonization, gasifying the coke, and rescuing from it its ammonia content, they could supply electricity at a price for heating and lighting which should command the patronage of "all." The present letter does not advance anything in defence of that position, nor anything that confirms the dissolution of the gas industry, unless the electrical people kindly permit it to live by handing over to it the conversion of its solid fuel into gas and the recovery of the bye-products. But Mr. Marshall promises us an article on the question, which will embody particulars of a scheme. We shall welcome and publish the article with pleasure; and, when to hand, it shall have very careful consideration. There is one question that Mr. Marshall asks (when expressing his firm conviction that the supply of illuminating gas has reached its zenith, and will gradually give place to electric lighting) to which reference may be made. He says: "If it were not so, why do some of our own corporate bodies—Tottenham, Herne Bay, and others seek to become purveyors of electricity?" The gas industry would have moved faster in this direction long ago had it not been for the discouragement of Parliament, who at one time were obsessed with the notion that there was greater value in competition than in economy. The responsible men of the gas industry have not been so foolish as to deny that there is a demand for electricity for lighting purposes. They might just as well deny that the gas industry has not more than doubled its output since electricity was in the field. What the "Tottenham, Herne Bay, and others" have claimed is that the two businesses can be run more economically in combination, and with less detriment to both, and so to the advantage of the local community, than run separately under different managements. The diversity of the business of the gas industry makes it innately the stronger of the two; and the increasing of the diversity by entering into the electricity supply business (where there is the demand) has been proved not to be to the disadvantage of the gas business, and certainly it is to the advantage of a newly-starting electricity business. The standpoint from which Mr. Marshall, as a loyal gas engineer, should attack this question is to show the Government that it would pay the nation to provide for the scrapping of the bulk of the electricity generating plant in the country, and hand the industry lock, stock, and barrel over to the gas industry, on condition that the low-temperature coal-carbonizing and recovery process is adopted, *plus* the gasifying of the coke, and *plus*, too, the recovery of the ammonia from the latter. Unless the Government will do this (presuming it accepts as true everything Mr. Marshall says), the electricity industry is not likely to seek the aid of the gas industry. And so, Mr. Marshall might just as well say right openly as enigmatically that, in his mature opinion, the gas industry is standing on the brink of disaster, just when it thought it was going to be of larger service in the world. Stay, there is an alternative. It is that the gas industry (which is better prepared) might bring the electricity industry to its knees by adopting Mr. Marshall's scheme, put gas into its holders for nothing, and offer to supply it to all the large users of electricity at a small cost to enable them to generate by means of gas-engines the whole of the current they require, no matter the purpose, at a fraction of a penny per unit. Without its large consumers, the electricity industry would be the one whose life would be in danger.—ED. J.G.L.]

Danger from Gas-Geysers.

SIR,—A matter of considerable importance to the gas industry has recently been brought to light. Two Canadian soldiers lost their lives through inhaling the fumes from gas-geysers used in the bath-rooms of two different places. Apparently, water had previously been heated by means of oil-burners; but, presumably on account of the unpleasant odour of the fumes from the oil, gas-burners had been substituted later. Instructions had been given that when the geysers were in use, the windows had to be left open—evidently danger was expected; but this precaution had not been taken. In one case, death was pronounced to have been caused by asphixiation; but in the other, by asphixiation and syncope. The latter is one of the well-known effects of carbon monoxide poisoning; consequently it would appear that the gas was incompletely burnt. The carbon dioxide produced when combustion is complete, according to Dr. Leonard Hill, is not poisonous. It might, however, produce asphixiation if concentrated.

In the old days incomplete combustion was one of the troubles met

with in gas-fires; but this difficulty has been completely overcome. It is of vital importance to the welfare of the gas industry that this trouble should also be removed from gas-geysers, or the public will develop a dislike for gas-heated apparatus of any kind, and electricians will not fail to emphasize the danger.

It may be that the comparatively low efficiency of gas-geysers is partly due to incomplete combustion of the gas; but it should not be a difficult matter to ascertain the cause of the latter. As a rule, a bath-room is not a well-ventilated place—in fact, too much ventilation would not be appreciated. There would be no chimney; and the only outlet for air would probably be through an open window. If a cool wind happened to be blowing against the window, it is extremely likely it would soon get shut, and with good reason. Even if it were left open, the fumes would not readily escape under the conditions. It is obvious, therefore, that means should be provided whereby the products of combustion of the gas could be entirely removed from the room in which the gas-geyser was placed. This could be effected by means of a flue, passing either into a convenient chimney or up the side of the building so as to reach above the roof.

In the opinion of the writer, it would be of advantage both to the gas industry and to the general public, if it were made compulsory to have all gas-geysers provided with satisfactory means for removing the products of combustion of the gas from the rooms in which they are used.

Leeds, Sept. 15, 1916. W. HARRISON.

Society of British Gas Industries and the Future of Engineering.

SIR,—I have pleasure in enclosing herewith copy of a letter written by the Chairman of this Society (Mr. H. M. Thornton) to the Secretary of the Engineering Meeting which was held at the Mansion House on Wednesday last.

A. L. GRIFFITH, Secretary.

46, *Queen Victoria Street, E C.*, *Sept.* 22, 1916.

[ENCLOSURE.]

T. C. Elder, Esq.,
Organizing Secretary, Engineering Meeting, Mansion House.

Dear Sir,—Your invitation to the Mansion House Engineering Meeting was duly received; and we shall hope to be present.

We are in full sympathy with the objects of the meeting, as we realize the urgent necessity of fully organizing, not only the engineering trades, but all our staple industries, so that by the association of men interested in any particular business a closer grip may be obtained upon the needs, not only of the world's business, but in regard to the movement for a better understanding between capital and labour.

We appreciate that the enormous burden of debt which has been created by the war, and which must still further be increased before peace is secured, makes it imperative that every effort should be made to increase production both during and after the war. It can only be by this means that we shall be able to recover from the effects following the struggle in which we are engaged.

In the event of further steps being taken as the result of your meeting, we feel quite sure you can rely on the manufacturers represented by this Society supporting, in every possible way, the strengthening and developing of the industries of the country.

Yours faithfully,
(Signed) H. M. THORNTON, Chairman.

The Widnes Idea of Patriotism.

A correspondent with the Mesopotamia Expeditionary Force, writing on Aug. 23 [before, of course, he had had an opportunity of learning of the rescinding by the Widnes Town Council of the resolution to which he refers], says the following expresses their feelings with regard to certain Widnes councillors.

We in Mesopotomia get little news of home and the progress of the war; and therefore news such as the Widnes town councillors provide is very disheartening. It fairly makes one's blood boil to read the shallow arguments they bring forward in refusing to sanction the erection of plant for the extraction of a larger percentage of toluol from the town gas. What is £1500 to the Widnes Town Council?

It is obvious that those who oppose the scheme have only a very limited knowledge of gas-works affairs—by such remarks as "gas-engines in the town to-day were short of power," &c. It would be a severe shock to Alderman G. Neil to know the different sorts and qualities of gas used for the successful running of gas-engines. He even suggests that the large cities and towns in France are not doing their share in toluol extraction! The councillor who seconds the amendment says he does so "at the risk of being unpatriotic," and actually confesses ignorance of his real duty.

We fighting out here sincerely hope this kind of thing is scarce in England, or whenever will the war be brought to a successful conclusion? This sort of people can never have felt the pinch of this great struggle, or have lost a near relative in the cause, or else they would be ashamed to act as they do. Send them to this awful climate, and what a changed body of men they would become!

Water Supply of Elland.—There is trouble with the water at Elland, which draws its supply from the Halifax undertaking. The drain on the Elland supply has been extremely heavy ever since the outbreak of the war, owing to local manufacturers being engaged day and night on Government work and drawing their water from the public mains. Reserve reservoirs, which replenish the supplies in the evening, when manufacturers, under normal conditions, have ceased work, have been constantly depleted, and the district has long been existing in a hand-to-mouth sort of way. The difficulty became worse later on; and the last straw was the bursting of a Halifax water-main last Thursday week, which entirely cut off the supply to Elland. The manufacturers were at once notified that they must not draw from the public mains until after the week-end.

REGISTER OF PATENTS.

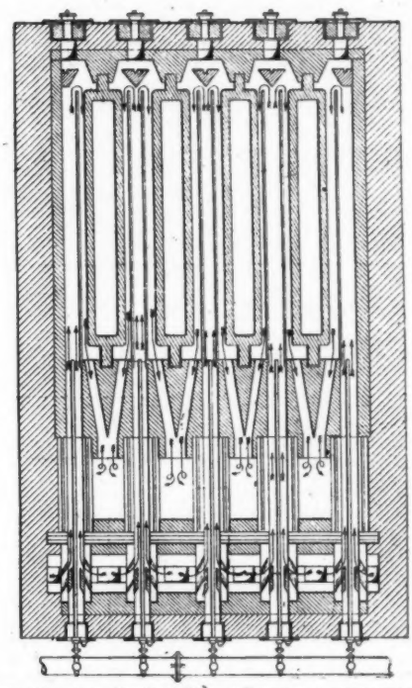
Furnace Settings for the Distillation of Coal.

WELLINGTON, S. N., of Mincing Lane, E C.

No. 7769; May 25, 1915.

This invention relates especially to furnace settings where vertical retorts are employed (charged at the top and discharged at the bottom) of oblong section. It has for its object "to effect the heating of the retorts uniformly and with efficiency, and in such manner that the temperature conditions throughout may be precisely regulated according to the character of the residue and bye-products required."

The retorts (preferably of oblong cross section and tapered outwardly towards the bottom) are set between series of horizontal partitions which form a vertical series of horizontal chambers beside and between the retorts and extend from one wall to the other of the setting. The chambers are provided with vertically disposed partitions by which the heating gases are compelled to take a tortuous path—that is, traverse the length of the heating chamber to and fro, so that the heating gases pass through a comparatively narrow space beside the retort before being discharged from the heating chamber. Two such vertical partitions may be provided in each heating chamber, so that the mixture of gas and air in the first instance and heating gases in the second instance may pass between the partitions, and on reaching the end opposite to that upon which the mixture of gas and air is admitted, the gases return and pass on the outer side of each of the partitions along the lateral spaces between the partitions and the adjacent retorts. The heating gases are thus directed in contact with the outer surface of the retort, and the circulation of them takes place within one plane.



Wellington's Vertical Retort Furnace Arrangement.

According to the invention, moreover, there is provided adjacent to the retorts a series of substantially vertical exhaust flues, corresponding in number to the number of retorts in the setting, into which the gases from the heating chambers at the sides of the retorts discharge. There is also a series of vertical air-flues in the setting, from each of which air may pass into the heating chambers of the vertical series.

A regenerator is provided beneath the setting, and special passages are formed, or else a special chamber in the setting, through which the air may pass before entering the respective vertical air-flues—the construction of the chamber or passages being such that the walls are heated by the exhaust gases passing out. Or, instead, a regenerator may be provided in which the flow of air and the exhaust gases may be reversed in the regenerator.

In carrying the invention into effect according to the construction shown, as the greater thickness of the charge of coal in the lower ends of the tapered retorts necessitates the expenditure of more heat in distillation than at the upper and thinner portion of the charge, the gas-pipes of the lower heating chambers are provided of greater capacity than those of the upper heating chambers, or are duplicated where necessary. For example, twin burners may be provided, one of which is fed with producer gas and the other with gas from the retorts. Similarly, the distance between the horizontal partitions forming the heating chambers is greater for the lower chambers than for the upper ones.

The horizontal air-passages may be formed as tubes of metal or be formed of refractory material, while the corresponding gas-pipe for each air-passage may pass centrally therethrough, and the horizontal air-passage may extend to the outer wall of the casing, where a valve plate may be mounted.

A series of vertical exhaust flues is built in the setting adjacent to the heating chamber; and ports are provided in the intermediate wall,

through which the gases may discharge from the lateral spaces of the heating chambers into the adjacent exhaust flue. In such an arrangement the series of vertical air-flues is arranged adjacent to the exhaust flues, and the exhaust and air-flues are arranged in line.

As to other constructional features, the arrangement of the furnace setting is substantially as described in patent No. 20,457 of 1914.

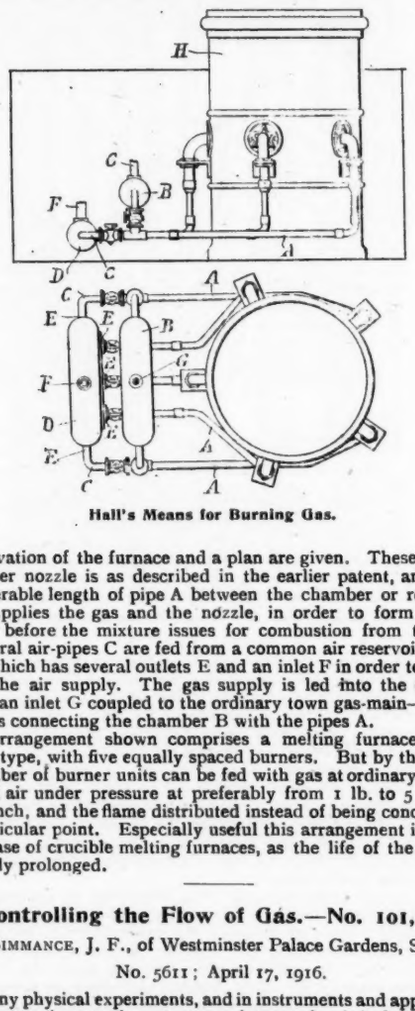
The patentee concludes his specification thus: I am aware that it has before been proposed in retort furnaces to provide two vertical walls of refractory material upon one side of the retort or group of retorts to form two passages upon that side, which traverse the retorts or retort groups, so that the hot gases coming from a gas-producer may lose heat to the setting before coming into contact with the retorts. In such a case the gases pass between one of the dividing walls between each retort group and one of the two vertical walls referred to, then passing back upon the other side of the wall into the space between the two vertical walls. The gases then return again upon the outer side of the second vertical wall into the space between the latter and the retort group. The gases then pass to the other end of the retort group and return in the opposite direction upon the outer side of the retort group, and thus pass out.

Means for Burning Gas.

HALL, I., of Aston, Birmingham.

No. 12,695; Sept. 4, 1915.

This invention relates to means for burning gas of the kind employing a plurality of burners fed with a supply of compressed air. Combined with a distributing air chamber or reservoir (of comparatively large capacity), having a plurality of outlets adapted to supply the individual burners, is a gas distributing reservoir with a plurality of outlets to supply the gas to the burners. There is also a plurality of air-pipes, with gas-pipes connected to them with nozzles as set forth in patent No. 5888 of 1914, from which the mixture issues for combustion. Comparatively long mixing-chambers are interposed between the junctions of the air and gas pipes and the nozzles.



Hall's Means for Burning Gas.

An elevation of the furnace and a plan are given. These show that the burner nozzle is as described in the earlier patent, and there is a considerable length of pipe A between the chamber or reservoir B, which supplies the gas and the nozzle, in order to form a mixing-chamber before the mixture issues for combustion from the nozzle. The several air-pipes C are fed from a common air reservoir or chamber D, which has several outlets E and an inlet F in order to distribute equally the air supply. The gas supply is led into the chamber B through an inlet G coupled to the ordinary town gas-main—a number of outlets connecting the chamber B with the pipes A.

The arrangement shown comprises a melting furnace H of the crucible type, with five equally spaced burners. But by the invention any number of burner units can be fed with gas at ordinary town pressure and air under pressure at preferably from 1 lb. to 5 lbs. to the square inch, and the flame distributed instead of being concentrated at one particular point. Especially useful this arrangement is said to be in the case of crucible melting furnaces, as the life of the crucible is materially prolonged.

Controlling the Flow of Gas.—No. 101,259.

SIMMANCE, J. F., of Westminster Palace Gardens, S.W.

No. 5611; April 17, 1916.

In many physical experiments, and in instruments and apparatus used for such experiments, the patentee points out that it is desirable for the gas to issue into the atmosphere from an orifice at an invariable velocity, at whatever time the experiment is made. The conditions influencing the velocity of efflux of the gas are numerous, and may be divided into two groups. The first group comprises conditions which are inherent in the apparatus and which are more or less easily under control in the design of the apparatus, or by the experimenter in using the apparatus. For example, if at a certain level in the gas-container the pressure of the gas inside is exactly equal to the pressure of the atmosphere at that level, there would be no flow of gas through an orifice in the container at the level, but merely diffusion according to the known laws. If, however, a pipe be carried upwards from the gas-container, gas will flow from the open end of the pipe or from a suitable orifice (provided the gas is of less density than the atmosphere) with a velocity which depends on the "head" or height of the orifice above the level, and on the densities of the gas and the atmosphere respectively. Conversely, if the gas is of greater density than the atmosphere, a pipe may be carried downwards from the container, and gas will flow from an orifice at the end of it. If the pressure of the gas inside the container is different from that of the atmosphere, the velocity of efflux will be influenced thereby. The second group comprises conditions the variations of which cannot be controlled by the experimenter. For example, the barometric pressure and the temperature of the atmosphere vary from day to day; and such variations, unless corrected for, influence the velocity of efflux of the gas.

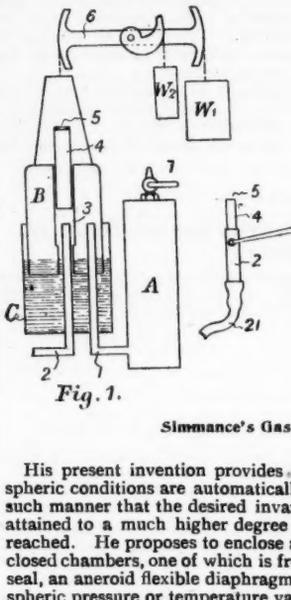


Fig. 1.

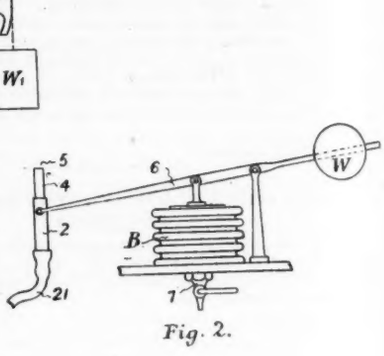


Fig. 2.

Simmance's Gas-Flow Controller.

His present invention provides means whereby variations in atmospheric conditions are automatically provided for in the apparatus, in such manner that the desired invariable velocity of efflux of the gas is attained to a much higher degree of accuracy than has hitherto been reached. He proposes to enclose a definite mass of air or other gas in closed chambers, one of which is freely expansible—a bell with a liquid seal, an aneroid flexible diaphragm chamber, or the like. As the atmospheric pressure or temperature varies, the volume of the enclosed air varies, and the expansible chamber rises and falls. The pipe from the gas-container is fixed to, and rises and falls with, the expansible chamber—thus varying the head which produces the flow of gas. This variation of the head is adjusted to give the correction for atmospheric variations, and ensures the invariability of the velocity of efflux of the gas. For example, suppose the gas has a density one-tenth part that of the atmosphere. At standard pressure and temperature of the atmosphere, the difference of density which produces a flow of gas from the orifice is 0·9—that of the atmosphere being taken as 1·0. If the density of the atmosphere changes to 0·9, that of the gas changes to 0·09; and the difference of density is 0·81—a smaller propulsive impulse than before. The chambers enclosing the confined air are now subjected to smaller external pressure of the atmosphere; the expansible chamber rises; and the "head" producing flow is increased. The increase of head is designed to compensate for the decrease of the difference of density.

Fig. 1 illustrates the invention, in which the expansible chamber is a bell with liquid seal. Fig. 2 shows a flexible diaphragm being used as the expansible chamber.

In fig. 1, the closed vessel A is in communication with the inside of the bell B by means of the pipe 1, which passes upwards through the bottom of the tank C containing the liquid into which the mouth of the bell dips. A pipe 2 for the supply of gas also passes upwards through the bottom of the tank—both pipes rising above the level of the liquid. A central tube 3 is fastened to the top of the bell; its open lower end dipping into the liquid. A tube 4 fits telescopically (and can be adjusted in position) in the tube 3; and an orifice 5 for the efflux of the gas is made in the top. Thus the gas flowing through the pipe 2 issues at the orifice 5. The bell is suspended and balanced.

In fig. 1, a beam 6 and counterweights W_1 W_2 are shown for this purpose. A vent cock 7 is fitted to the vessel A or bell B for the purpose of equalizing the pressures on the inner and outer surfaces in the initial calibration of the apparatus. In fig. 2 the arrangement is functionally analogous to fig. 1. The gas-supply pipe 2, which in this case rises and falls with the top of the flexible diaphragm B, is joined to the fixed gas-supply pipe by a flexible tube 21.

Lewes Gas Company.—The Directors of the Company reported that the revenue account for the half year ended June 30 showed a profit of £312. After providing for interest on mortgages, &c., the balance of net revenue was £3652. A dividend was recommended for the six months at the rate of 3 per cent. upon the original capital stock and £2 2s. per cent. on the additional capital stock. The Directors regretted that, owing to the largely increased cost of coal and other materials and the difficulties created by the war, they were unable to recommend the usual rates of dividend. The same reasons made it necessary that they should raise the price of gas 6d. per 1000 cubic feet, as from the 29th inst. In submitting the report to the proprietors, the Chairman (Mr. M. S. Blaker) said that the 3 per cent. dividend as now recommended, with the 4 per cent. for the previous half, made 7 per cent. for the year; and, having regard to the abnormal conditions, he did not think they were doing so badly in getting 7 instead of 10 per cent. The works had been improved during the past six months by the provision of new carburetted water-gas apparatus as well as a small booster plant.

LEGAL INTELLIGENCE.

WATER SUPPLY TO OCCUPIED PREMISES.

"Absence" or "Removal."

At the Southend County Court last Thursday week, before His Honour Judge TINDAL ATKINSON, the Southend Water Company brought an action against Mr. W. H. Douglas, of Westcliff, for the sum of £3 18s. 3d. for water supplied.

Mr. J. G. DRYSDALE appeared for the plaintiff; Mr. H. SLESSER defended.

Mr. DRYSDALE said the claim was for three quarters' water-rate to the end of June; the defence being that Mr. Douglas was not actually living in the house throughout this period, having gone to Madeira. He thought, however, it would not be denied that the house was furnished, and therefore was deemed to be in occupation. While there was a service-pipe, the liability continued. Defendant, while disputing the claim, had sent 10s. to cover out-of-pocket expenses in cutting-off the water; while the Company offered to accept half the rate to settle the matter. A person must tender notice when he gave up occupation, if he wished to escape liability. As long as a person left his house furnished ready for his return, he was liable. If a man left his furniture there, and gave no notice to the Company, he was as liable as if he was living there. The Company had to supply the consumer as soon as the person connected his pipe to the main. The Company had no control over the stopcock, which in this case was in the house; and anyone who went in could use the water. The first written notice defendant sent to the Company was after the three quarters became due.

Mr. SLESSER contended that under section 71 of the Water-Works Clauses Act, the question of occupation was not the primary point at all. It was a question whether the defendant had quitted or removed from his dwelling. The Act said that a person who had quitted or removed from his dwelling should not be liable.

His HONOUR: It is a question if this means final removal.

Mr. SLESSER admitted that it was a matter for argument, but said he did not think the Legislature had in view a final removal, never to return. It was a question whether the defendant did quit the house, rather than cease to occupy. There were many interpretations of the word "occupation;" and there might in this case have been legal occupation. He submitted that the word "removal" meant what it said, and was not synonymous with the word "occupation" in the varying legal senses in which it was used. The word meant by reason of shutting-up his house he was, in fact, no longer a consumer of water—having removed. If the word "removal" applied only to a person who had ceased to be in occupation, then the liability for the water-rate depended, not on whether the Company supplied any commodity, or on any burden which they bore in respect to this pipe, but on whether the man at some future time returned to his house. He asked the Judge to say there was no reason why he should give such a strained interpretation of the words "removal" or "quit."

His HONOUR thought the word "quitting" was a stronger word than "removal." It meant leaving the house.

Mr. SLESSER replied that under this section the word "quitting" meant the same thing as the word "removal." The governing word was "removal." The defendant went away to Madeira for over a year; and it was a question of fact as to whether he had not quitted the house.

His HONOUR said he should give judgment for plaintiffs; but he should give the defendant leave to appeal, if necessary. He thought if the Legislature had intended the section to cover temporary removal, it would have used the word "absence." He also thought the word "quitting" could not be employed in the sense of mere removal, because when they talked of quitting it meant permanent quitting. He granted costs on the higher scale.

Wages Dispute at Bingley.

A short strike, two or three weeks ago, of employees at the Bingley Gas-Works, over a question of wages, proved to be an ill-advised step; for their Union had already agreed to arbitration on the subject of the demand for a 3s. war bonus. When the position of affairs became better understood, the men returned to work, and Mr. W. H. Stoker (appointed for the purpose by the Chief Industrial Commissioner of the Board of Trade) held his inquiry into the dispute. At a meeting of the District Council last week, the result was made known. The Chairman of the Gas Committee (Mr. Turner) said the award was for a war bonus of 3s. per week to men with wages of 30s. or less per week, and 2s. 6d. to men with over 30s. per week; and the Arbitrator had fixed these payments to take effect on Sept. 1. Mr. Snowden said he did not desire to discuss the question generally; but he wished to ask if the workmen were prepared to accept the award on the point of the date at which the alteration of pay should take effect. He was inclined to think they were under the impression that it should date from the time when their application was first made some months ago. He did not think it came within the terms of reference to the Arbitrator to fix the time. The advance should be retrospective; and he thought if it were it would avoid any possibility of further friction. The Chairman (Mr. J. H. Whitwham) remarked that the interests of all would be best served by quietly accepting the award. Mr. Dawson said the question had been submitted to arbitration, and the award was binding. To make an alteration in the terms of the award, a special resolution of the Council would be required, of which notice should have been given. The Deputy-Clerk expressed the opinion that it was clearly part of the Arbitrator's duty to define when his award should have effect. He did not see how it would be possible to alter the award, both parties having agreed to arbitration, or how the Local Government Board Auditor would sanction any alteration of it. After some further discussion, Mr. Snowden said he would let the matter rest where it was.

MISCELLANEOUS NEWS.

SERIOUS FIRE AT THE DAVIS GAS-STOVE COMPANY'S LUTON WORKS.

£40,000 Damage.

Early last Wednesday morning, the Luton works of the Davis Gas-Stove Company, Limited, were the scene of a disastrous fire; the outbreak being fraught with grave peril to adjoining property, though happily attended with no loss of life or serious personal injury. Starting, as is surmised, in the testing shops, the flames must have spread with great rapidity, judging from the tremendous blaze created, and by the extent of the damage, which is roughly estimated at about £40,000. A vast quantity of stores, the enamelling, fitting, and other shops—one-storey erections covering altogether more than two acres of ground—were almost completely destroyed; and had the strong wind encountered at the time blown from the opposite direction, the entire works must have been gutted.

Members of the Davis Company's own works fire-brigade, warned by automatic alarms in their bedrooms, arrived quickly on the scene, and lent prompt and energetic support to the expert work of the town brigade. Mr. Harold N. Davis (the Managing-Director chiefly concerned) also arrived early, information of the outbreak having been telephoned to him at his residence at Harpenden; while loyal service was rendered by the various departmental managers and others of the general staff who were able to put in an appearance.

Fortunately, the whole of the foundry section, adjacent shops, and executive offices, as well as the technical laboratories and experimental shops, all remain intact. Nevertheless, much important work will be seriously interrupted; and about 200 employees (mostly women) are affected, though not thrown out of employment, by the partial stoppage. By the rapid completion and fitting-up of temporary workshops, however, the erection of which is proceeding day and night, it is hoped before long to restore something like normal working conditions, and to resume deliveries with as little delay as possible. Meanwhile, the fullest possible advantage will be taken of the Davis auxiliary works at Camberwell.

We are informed that generous offers of assistance during the temporary dislocation were immediately made to the Davis Company by no fewer than four competitive gas-stove makers, as well as from other engineering works in the locality; and it is with pleasure that we record so gratifying a manifestation of the excellent spirit animating the great manufacturing section of the gas industry.

DEVONPORT GAS-WORKS ACCOUNTS.

The accounts of the Devonport gas undertaking for the year ended March 31, 1915, which have just been presented to the Plymouth Corporation, show that the revenue was £83,794, and the expenditure £61,775, leaving a gross surplus of £22,019.

The gas sold was 480,529,343 cubic feet, against 460,625,439 cubic feet the previous year, and included 219,186,000 cubic feet to private consumers, 43,844,000 feet to Government establishments, 190,619,000 feet to slot consumers, and 26,879,000 feet for public lighting. The receipts from sales of gas were £56,695; from rentals of meters, stoves, &c., £8794; from residuals, £15,759. On the expenditure side of the account, the chief items were manufacture of gas, £47,826; distribution, £2534; maintenance of stoves, &c., £813; public lamps, £1461; residuals, £2959; rents, rates, and insurance, £1761; management expenses, £2087; allowances to employees on military service, £299.

The gross profit of £22,019 was carried to the net revenue account, from which £7763 was paid in interest, £9768 for redemption of capital, and £425 in income-tax. The balance of £4122 was carried to the reserve fund. Out of the reserve fund, the Gas Committee paid during the year £1874 for coal-unloading machinery, £272 for new sulphate of ammonia apparatus, £1356 for telpher plant, and £841 for stoking machinery.

GAS FUEL FOR ELECTRICITY PRODUCTION AT BRIGHTON.

Last Thursday's issue of the "Electrical Times" said: "We have referred more than once to the scheme put forward by Mr. John Christie, the Engineer and Manager of the Brighton Corporation Electricity Department, for the use of gas fuel at the Southwick power house. Mr. Christie submitted a report on the subject to the Electricity Committee, which, at its meeting on Tuesday of last week, approved of his recommendations. To-day the Council will receive the Committee's report; and, it is to be hoped, will adopt the scheme. In view of the small amount at stake, and the very substantial saving in coal consumption which Mr. Christie anticipates to result from the use of gas fuel, the proposition seems well worth a trial."

Our contemporary continues: By the courtesy of Mr. Christie, we are enabled to publish the following details based upon his report to the Electricity Committee—this report having been drawn up in connection with a letter dated June 1, from Mr. F. W. Salisbury Jones on behalf of the British Coalite Company. It is suggested that the Corporation should lease to the British Coalite Company 6 acres of its vacant land to the east of the Southwick power house, and on this site the Company would erect a wharf, coal-handling plant, and coal-storage accommodation, together with retorts and plant for carbonizing coal on the low-temperature process.

Mr. Christie points out that at the present time the bulk of the coal in this country is burnt in a very crude and inefficient manner—only a small portion of the total heat being utilized effectively, while all the

valuable residuals are destroyed and lost by passing up the chimney in the form of smoke and soot, thus needlessly polluting the atmosphere.

It is claimed by the Company that the adoption of the low-temperature carbonizing process enables the maximum heat value to be obtained from the coal in the shape of "Coalite"—a smokeless fuel excellently adapted for domestic use—while the gas and all the other valuable distillates in the shape of tar, sulphate of ammonia, benzol, toluol, and light and heavy oils are recovered, and can be employed advantageously in the manufacture of aniline dyes, fertilizers, rich motor spirit, high explosives, &c., for which this country has hitherto very largely depended on imports from Germany and abroad. The Company suggest that by the establishment of works of this description throughout the country our coal supplies would be conserved for the benefit of the nation, and thus enable many of these important chemical industries to be fostered at home.

As a bye-product to the process, there would be a large volume of surplus gas available; and it is proposed that the Corporation should purchase this from the Company at a low figure (in comparison with the corresponding cost of coal), and by adapting a portion of its existing boiler plant at a comparatively small outlay, for firing by means of gas instead of coal, be enabled to utilize the waste heat contained in the gas for steam-raising. In this way fuel costs would be reduced substantially and savings effected in labour, while much dirt and dust incidental to the present method of working entirely with coal would be avoided.

If the scheme is adopted by the Council, it will be necessary for the Corporation to enter into an agreement with the British Coalite Company; and the following are the chief headings under which Mr. Christie suggests that such an agreement should be drawn up:

1.—The Corporation to grant to the Company a lease, for a term of 25 years, of 6 acres of land fronting the canal immediately to the east of the power house at Southwick, at an annual rental equivalent to the interest and sinking fund charges on the capital outlay, which amounted to £1800, or (say) £60 to £100 per annum, with the option of renewal for further periods to be mutually agreed on.

2.—On this site the Company, at its own expense, to construct a wharf, do the necessary dredging, and provide coal-handling plant, bunker accommodation, &c., together with retorts and plant capable of carbonizing 200 tons of coal per day.

3.—It is estimated that the first installation of plant will yield, in addition to the "coalite" and other residuals, approximately 4,800,000 cubic feet of gas per day. This would be delivered to the Corporation's service main for firing three boilers. It would be delivered at 3 inches water pressure and of a standard thermal value of 300 B.Th.U. per cubic foot, subject to a margin of 5 per cent. up or down.

4.—The Corporation would undertake, so far as its load permits, to utilize this gas to its fullest extent in preference to solid fuel, and would pay for same by meter at the rate of 1·5d. per 1000 cubic feet with coal at 20s. per ton as a base, subject to an increase or decrease at the rate of 5 per cent. for each 1s. per ton that the cost of coal varies above or below this figure. With regard to the basis price of coal, it is understood that the coal to be purchased is of a suitable class for the special purpose for which it is intended, and that the price is the then current price for coal, including freights, dues, and cost of placing same in bunkers. Evidence should be available showing the actual price paid.

5.—The Corporation to supply the Company with the necessary energy for operating its machinery, which would have an approximate demand of 100 KW. (D.C. or A.C.) whichever may be decided as the most convenient, at the rate of 0·6d. per unit with coal at 20s. per ton delivered to the Southwick bunkers—subject to an increase or decrease at the rate of 5 per cent. for each 1s. per ton that the cost of coal varies above or below this figure. With regard to the basis price of coal, it is understood that the coal to be purchased is of a suitable class for the special purpose for which it is intended, and that the price is the then current price for coal, including freights, dues, and cost of placing same in the bunkers; and, on demand, evidence should be given showing the actual price paid. [This virtually means that the electricity at present used at the works and charged for in the running cost of generation for driving coal conveyors, fans, stoker motors, and other auxiliary plant in the Corporation power house would be used instead for driving the machinery on the Company's premises and be paid for by the Company—thus affording an additional source of revenue to the Electricity Department.]

6.—The Corporation to adapt three of the present nine boilers for burning gas instead of coal. This can be done by removing the present grates and substituting burners, at an estimated outlay of £750, *plus* the cost of the necessary piping. Two out of these three boilers would be used almost continuously with the full output of the gas available for the steady 24-hour load, and steam would only be raised by coal on such of the remaining boilers as were required to meet the varying peak loads.

7.—It is estimated that the surplus gas will produce at least 7,500,000 units of electricity per annum; and assuming that 110 cubic feet of gas are required per KW.-hour as against 3 lbs. of coal, the cost for fuel with coal at 20s. per ton will work out at 0·165d. per unit for gas, as against 0·3213d. for coal, equivalent to a saving of 0·1563d. per unit, representing in round figures £5000 per annum for this output. Further saving due to reduced labour in trimming coal, removal of ashes, improved cleanliness of the boiler-house and station, lessened radiation and stand-by losses, will also be effected; while, if the available gas is sufficient to generate a larger output, the saving naturally would be proportionately greater.

In Mr. Christie's opinion, the scheme has everything to commend it to the favourable consideration of the Council, as it will enable the Electricity Department to effect substantial reductions in the cost of producing electrical energy. The Company at present are putting down the first plant in this country at Barugh, near Barnsley; and the Yorkshire Electric Power Company at one of their power stations are under contract to take the residual gas for firing their boilers in the same way as is proposed in the scheme above set out.

Early in July Mr. Christie visited the works. The plant is similar to that which the Company proposes to instal at Southwick; and Mr. Christie had an opportunity of seeing one of the boilers at the Yorkshire Electric Power Company's works being fired by gas fuel instead of coal; and it was doing its work admirably. Mr. Christie has no hesitation whatever in stating that if such an arrangement can satisfactorily be made in connection with the Brighton undertaking, it will effect most substantial economies. With the consent of the Town Clerk, Mr. Christie consulted Mr. W. B. Woodhouse, the Engineer to the Yorkshire Electric Power Company, who has had a very extensive experience with gas-fired plant; and his report bears out fully the views of Mr. Christie.

Mr. LINTOTT, proposing, at Thursday's meeting of the Town Council, the adoption of the Lighting Committee's report recommending the adoption of the scheme, said he thought it would turn out to be a very satisfactory one as far as their own electricity undertaking was concerned, because before the Council would be called upon to expend any money the Company would have to spend a very large sum on buildings and plant. If it were the success they had every reason to believe, the Committee would effect a very great saving in the cost of fuel; whereas, on the other hand, if it turned out a failure, the Committee would stand at no great loss, in view of the increased value of the site they proposed to lease.

Alderman COLBOURNE protested against the scheme being agreed to by the Council in a hurry. He said there was no evidence before the Council that the process had been a success up to the present; and before they were committed to anything, there should be a thorough investigation. It would be better to go into committee to discuss the whole question with Mr. Christie. It seemed to him that the British Coalite Company were not going to carry this out at all, but were going to provide a subsidiary Company for the purpose; and he noticed that Mr. W. B. Woodhouse, in the report he had made to the Committee, said, after dealing with the prospects of success: "No one can say more on this point until practical experience has been gained with the new type of coalite plant now in course of construction at Barnsley." Why could not the Council wait until they had some practical illustration of whether it was going to be a success?

The Council then went into committee on the question; and when they resumed business nearly two hours later,

The TOWN CLERK stated that they had considered the report of the Lighting Committee, and recommended that further consideration of the report be deferred until the meeting of the Council in October; and that in the meantime members desiring further information should communicate with the Committee.

Mr. LINTOTT said, although he felt personally it would handicap the whole thing, he had been advised to accept this, and would do so.

The recommendation was then carried without further comment.

TOWNS GAS FOR MOTOR-CARS.

[Extracts from a Paper read by Mr. R. Liggett before the Foremen's Association of the Glasgow Corporation Gas Department, Sept. 15.]

You all know, of course, that the petrol-engine used on motor-cars is, in simple words, an ordinary gas-engine. Now, an ordinary gas-engine is controlled by various mechanical means—working usually upon the "hit-and-miss" principle. By this means a charge of gas is prevented from entering the combustion chamber, when the engine exceeds the speed limit for which the engine has been set. This method of controlling a stationary gas-engine is perfectly adapted for the purpose. I am not sure it can be very well improved upon for engines running at a regular speed at all times. Yet the method is not at all adaptable, in my opinion, for engines such as those used on motor-cars, where the speed is constantly being changed from fast to slow, or slow to fast, at the will of the driver. I therefore set myself to devise something which would do the work satisfactorily, and give the control desired.

My first attempt to drive a motor-car engine with towns gas was done with a common grill injector. I removed the ordinary petrol jet from the carburettor, and inserted the grill injector by means of a plate screwed to the flange seat of the petrol jet, and then used the throttle in the usual way. I succeeded with a little coaxing, and some willing helpers, in getting a move on the engine, and finally a run at the rate of about fifty revolutions per minute—the movement of the throttle keeping a slight control on the engine. The success which attended this effort was such as to lead me on to the endeavour to make a proper control. This I succeeded in doing, and early in the year the new controller was tried on several types of engines—including a 25 H.P. Halley and a 16 H.P. Albion.

One of the engines tried was driven at a very high speed—considerably over 1000 revolutions per minute—and was also reduced to a speed as low as that given by petrol, by the movement of the usual throttle-lever on the steering-wheel. The car was also driven backwards and forwards in a space of 12 feet, with brakes applied—this movement of the car being allowed for by the use of 12 feet of flexible tube attached to the ordinary gas-pipes.

During the trial there was no sign of early firing due to weak mixture, with its consequent kick or bump, which tends to destroy bearings and bend connecting rods—the controller regulating the mixture at all speeds.

The subject became very interesting at this stage; and I began to look about for some means to store gas. I obtained a barrel, and, after expelling all the air, 20 cubic feet of gas was pumped into it, at a pressure of 30 lbs. The time taken by the engine to consume the 20 cubic feet of gas was twenty minutes. The barrel was filled a second time with the same quantity of gas, at the same pressure, and again coupled-up to the engine, but without the governor; the gas-valve on the barrel being regulated by hand. The result on this occasion was a

full-speed run (1000 revolutions per minute) for six minutes. This works out at 200 cubic feet of gas per hour, costing 6d. for a 25 H.P. engine.

Being anxious to obtain some further information on the subject of gas consumption, I again fixed the controller on the engine (a 25 H.P. Halley) and coupled-up to the gas-pipe, through a 60-light meter. The engine started very easily. After a short run, the meter index was taken, and watched very carefully for fifteen minutes; the engine meanwhile running at full speed (1000 revolutions per minute). The result was a consumption of 40 cubic feet of gas, working out at 160 cubic feet per hour, costing less than 4½d.

These results caused me to set about finding or making a suitable governor. A governor, for this class of work, to be successful, must be able to drain the gas-cylinders, from their highest pressure down to atmospheric pressure—issuing at the outlet side of the governor at a constant pressure of (say) 3 inches. The governor must also be able to pass any quantity of gas up to 200 cubic feet per hour, or more, according to the power of the engine. It must be able to withstand the jarring and jolting of the wheels on the roughest roads, without any noticeable variation. A governor to combine these qualities, where the initial pressure is always diminishing, may possibly be a large order. Water or mercury, as seals, in my opinion, are out of the running.

With the above thought before me, a start was made; and, after one or two failures, I arrived at one which, so far, has done very well. Rubber has been called upon to play a very important part in the governor; the bell being formed from it. The high-pressure counterbalance on the valve-stem is formed from leather; the valve being of the usual cone type, and adjusted by weights on the bell.

High-Pressure Gas Cylinders.

In connection with this subject, I inquired at the British Oxygen Company at Polmadie, as far back as March last, with the view of getting some information regarding the weight and dimensions of their gas-cylinders. Cylinders to contain 100 cubic feet of gas weighed anything from 120 to 128 lbs.; length, 4 ft. 7 in.; diameter, 7⅛ inches (outside measurements). The pressure in the cylinder was 1800 lbs. per square inch.

Having had some previous experience with the smaller types of these cylinders, I had no faith in them for motor-cars, except from an experimental point of view. In my opinion, the pressures in the cylinders are too high; the cost of compressing also being prohibitive. The cylinders for this class of work should be of large dimensions; so that the pressure may be kept as low as possible.

Two cylinders of not less than 8 cubic feet capacity (three cylinders if possible) could be placed one on each side of the chassis, below the footboards, between the front and rear wheels. The third might be placed at the back of the rear wheels, across the chassis. The greater the capacity of the gas-cylinders, the lower the pressure required for a given quantity of gas—say, 1000 cubic feet—which should go a long way in the day's work of a 25 or 30 H.P. two-ton waggon; and, on this principle, the cylinders could be made much lighter, and the working cost reduced all round.

Another cylinder would also be required—a low-pressure cylinder of about 1 cubic foot capacity. The ordinary petrol tank would do very well for this purpose. Between the high and low pressure cylinders, the governor would be placed, to reduce the gas from high to low pressure; and in this manner the gas would get time to regain its normal condition. The engine would then be supplied at low pressure, which I think is necessary for the efficient working of a gas-engine. Waste is also prevented.

Compressing Arrangements.

Each motor-car should be equipped to do its own compressing. I am convinced that in this direction only lies success. You will have noticed, in my remarks on cylinders, that I favour light, roomy cylinders, with the object of doing away with the need for very high pressures—thereby giving the engine every possibility of reasonable success to do the compressing.

The gas should not be compressed above 1000 lbs.—500 lbs., if possible, would be more to my liking. But the very lowest pressures should be aimed at, bearing in mind that by doing so the initial costs and also the running costs will be kept low.

The pump to be used for compressing purposes could be operated from the gear-box with very little alteration to the latter, or, better still, by a special gear-box made for the pump itself, and attached by rack-and-pinion to the carden or propeller shaft.

Results Attained.

I do not say that the results of the few simple experiments which I have been able to place before you are good results, or even fair; but I do say that they warrant the Corporation spending a few pounds on further experiments, so that actual results may be obtained.

In connection with this matter, a letter was sent on June 10 to the Gas Committee drawing attention to the controller mentioned in the first part of this paper, and asking for facilities and assistance to complete the final experiments.

I might here also mention that a Special Committee, composed of five members, along with the General Manager (Mr. Alex. Wilson), have been appointed to make inquiries on the subject.

Petrol has one point and one point only to recommend it, and that is a great power can be carried in a very small tank. This point must be admitted to be a good one in its favour, for pleasure cars or cars travelling very long distances, but for short distances or town work, gas should prove a serious competitor to petrol and electricity.

It is within the power and it is the right of the gas engineer to prove that towns gas is a practical and economical fuel for motor traction, after which the motor engineer will follow with the necessary alterations in the mechanism.

Increase in Price at Goole.—The price of gas at Goole to ordinary consumers is, from the 1st prox., being raised from 3s. 6d. to 3s. 9d. per 1000 cubic feet. As already reported, the Urban Council last year sustained a loss of £2700 on the gas-works.

THE CYANAMID PROCESS IN AMERICA.

The Case for Gas-Works Residuals.

Writing in the American "Gas Institute News," on the position of the gas industry in the nation's scheme for preparedness, Mr. W. H. Gartley urges that few of the members realize how important the carbonization of bituminous coal and the manufacture of water gas become in any scheme of preparedness or in actual war. Any Congressional legislation now pending, passed, or to come that will strike a blow at the value of gas-plant residuals, is a blow against adequate preparedness. If Congress passes a law authorizing the expenditure of some $15,000,000 for the erection of plant to make nitric acid for war munitions in time of war and in peace time to convert that nitrogen into enough fertilizer to supply the whole country, thereby destroying absolutely our return for ammonia, should not, he asks, a representative body of the American Gas Institute go before the proper Committee of Congress or officials designated to carry out such a law, and explain the effect, not only on the gas business, but on the whole munition business of the country?

After indicating the processes by which nitric acid is now made in Europe, Mr. Gartley says that the cyanamid process of the American Cyanamid Company at Niagara Falls now appears to be in favour in Washington. Mr. Washburn, the Company's President, says that they intend, if the Government accept their proposition, to make the equivalent of 2,000,000 tons per annum of standard fertilizer in peace time, or 90,000 tons of nitric acid yearly during war. For more than twenty years the selling price of sulphate of ammonia has stood with little change at approximately $60 per net ton, although in the early months of 1914 it had declined to as low as $52. This was unmistakable evidence that the supply had exceeded the demand. If the propaganda after years of hard work of the Barrett Manufacturing Company and others, looking to an expansion in the use of fertilizers by farmers and planters, and more particularly to the extended use of fertilizers containing sulphate of ammonia, could not keep up the selling price of this bye-product, what are we to expect when 2,000,000 additional tons of domestic fertilizer are offered to the market?

The avowed purpose of the President of the American Cyanamid Company is to produce a large quantity of cheap fertilizer; and his proposition to the Congressional Committee is for the Government to develop 100,000 primary electric horse-power, or an installation of 125,000 continuous horse-power, on the switchboard at an estimated cost to the Government of $13,000,000; to erect under private capital a cyanamid plant for making fertilizer; paying the Government 3 per cent. on its investment for water-power development; the Government to expend $5,000,000 for plant, idle during peace, exclusive of the fertilizer plant, for the manufacture of 90,000 tons of nitric acid yearly, and to have on the ground buildings and material by which an additional 90,000 tons can be made. This proposition means that Congress shall hand over to the American Cyanamid Company 125,000 hydro-electric power, not procurable except by Act of Congress, in order that the Company shall during peace times make at low cost all the fertilizer the country will use. On its face, this is a business proposition to stand on its merits. It gives the country a supply of nitric acid in time of war, and a Government protected monopoly of the fertilizer business in time of peace. But if, in doing this, it will in times of peace so destroy one source of income of that industry upon which the Government must absolutely depend for their other necessary raw materials for the manufacture of explosives, it has defeated the very purpose for which the Government funds were expended.

This plant will, when completed, make a maximum of 180,000 tons of nitric acid yearly for the Government in war times; and at such times the manufacture of fertilizer will cease, since it is not conceivable that the hydro-electric installation by the Government will be in excess of that required to make all the nitric acid the plant can turn out in war time. What advantage is there for the Government in this proposition, when the supply of ammonia from coal distillation in coke-ovens and gas-works will in 1917 yield over 500,000 tons of nitric acid? The greater the demand for gas-works ammonia, the greater the production of benzol, toluol, and other explosive bases; the greater the production of fertilizer by the cyanamid process, the less the production of these absolutely necessary bases for explosives.

Opposed to this proposition of the American Cyanamid Company, now in successful operation at Niagara Falls (Canadian side), is the proposition of the Du Pont Company, who simply ask of Congress permission to develop, at the Company's expense, sufficient hydro-electric power to make 40,000 tons annually of nitric acid. No expense to the Government and no Government protected monopoly of the fertilizer business is included. The Du Pont Company will spend $20,000,000, and add 40,000 tons to the country's nitric acid capacity per year, to be used by them in times of peace, as in war, solely in the manufacture of explosives.

It appears to Mr. Gartley that the American Gas Institute should avail themselves of the opportunity yet open to be represented before the officials appointed in Washington to decide this question. What, he asks, will be the effect on our anti-war commercial conditions when we must meet the offensive and defensive commercial alliance of the Entente Powers and the well-known "dumping" of manufactured products by the German nation? If they cannot dump their goods on the English, French, Italians, and Russians, are we not in for a deluge from Germany to augment that proposed by the American Cyanamid Company in the matter of fertilizers?

Petrol-Saving Hint.—Writing under this heading, in the "Daily Mail" last Tuesday, Mr. O. H. Bonham-Carter says: "A great saving of petrol would result if manufacturers of aircraft engines would follow the excellent example of a well-known firm of makers of motor-cycles, by using coal gas from the main for testing their engines on the bench. This will work very satisfactorily if the gas-pipe is attached direct to the induction-pipe; a tap being used to control the supply of gas. I do not know the exact number of gallons of petrol used when testing an aircraft engine on the bench; but I believe it is at least 20.

NOTES FROM SCOTLAND.

Summer Time Act Effect in Glasgow.—With regard to the Summer Time Act in Glasgow, for the period from May 27 to Sept. 16, the value of the 118,000,000 cubic feet of gas saved in lighting is, at the present domestic rate of 2s. 6d. per 1000 cubic feet, equal to £14,775. The quantity of gas sent out for all purposes was 1,995,008,000 cubic feet, as compared with 2,021,928,000 feet in the same period last year—a decrease of 26,920,000 cubic feet, equal to 1·33 per cent. For lighting purposes only, the output from May 27 to Sept. 16 was 589,956,000 cubic feet, compared with 708,160,000 feet—a decrease of 16·69 per cent. In the eighteen hours from midnight until 6 p.m., when the gas for the most part is required for power, the quantity sent out was 1,405,052,000 cubic feet, as against 1,313,768,000 feet—an increase of 91,284,000 cubic feet. These last figures prove that the output of the Gas Department under normal conditions is extending at practically the same rate as in previous years, although, owing to the Summer Time Act, there has been a reduction in the total output.

Grangemouth Gas Matters.—The Grangemouth Town Council, at their meeting on Monday of last week, adopted the report of the Special Gas Committee stating that it had discussed with the Manager (Mr. C. Winton) the causes of the deficient gas production and the remedies. The Manager had stated that, after a couple of years' use, the results obtainable when the new settings were introduced could not be secured, but that primarily the cause was inefficient labour. The Committee considered that closer supervision by the Manager of the production of gas in the works was required than could be given under existing arrangements, and that it was necessary, to enable this to be effected, and for various other reasons, to have an Assistant Manager. They recommended that a man capable of acting as a working assistant to the Manager be advertised for, at a salary of £125 per annum.

Sulphate Prices in Scotland.—According to the Glasgow correspondent of "Engineering," at a meeting of the Directors of the Scottish Chamber of Agriculture held last Thursday week, attention was drawn to the fact that, notwithstanding the arrangement which had been announced by the Board of Agriculture with reference to the price of sulphate of ammonia, purchasers have had the greatest difficulty in procuring adequate supplies from the manufacturers. This has given rise to some considerable dissatisfaction, as the rate which was fixed—£15 per ton, with the option of buying smaller quantities—was to hold good until the end of September.

CURRENT SALES OF GAS PRODUCTS.

The London Market for Tar, Tar Products, and Sulphate.

LONDON, *Sept.* 25.

Pitch continues firm, and business for export is reported at 20s. per ton net, in bulk, at makers' works. There is a fair amount of inquiry, but lack of suitable freightage makes things difficult. Creosote remains unchanged. Solvent naphtha is in good demand; the current value being 2s. 4½d. per gallon, net and naked, at makers' works, for 90-160 quality. Anthracene, 48-50 per cent., is 3d. per unit net, casks free, at makers' works. Crude tar is worth about 2¾d. per gallon, delivered.

The export price of 25 per cent. sulphate of ammonia is firm at £17 7s. 6d. per ton net, into buyers' bags, at makers' works.

Tar Products in the Provinces.

Sept. 25.

There is nothing fresh to report in the market for tar products. In pitch, there is very little inquiry; but it is having no effect on the market. Solvent naphtha is in fair demand; but heavy naphtha is quiet. Creosote is still weak.

The average values of gas-works products during the past week were: Gas-works coal tar, 15s. 6d. to 19s. 6d. Pitch, East Coast, 16s. to 16s. 6d. per ton; West Coast—Manchester, 15s. to 15s. 6d., Liverpool, 16s. to 16s. 6d., Clyde, 17s. to 18s. Benzol, 90 per cent., North, 10½d. to 11½d.; 50-90 per cent., naked, North, 1s. 3d. to 1s. 4d. Toluol, naked, North, 2s. 3d. Coal tar crude naphtha, in bulk, North, 6½d. to 6¾d. Solvent naphtha, naked, North, 1s. 10d. to 1s. 11d. Heavy naphtha, North, 1s. 2d. to 1s. 3d. Creosote, in bulk, North, 2d. to 2¼d. Heavy oils, in bulk, 3⅞d. to 4d. Carbolic acid, 60 per cent., East and West Coasts, 3s. 4d. naked. Naphthalene salts, 75s. to 80s., bags included. Anthracene, "A" quality, 2½d. to 2⅞d. per unit; "B" quality, nominally ¾d.

Sulphate of Ammonia in the Provinces.

LIVERPOOL, *Sept.* 23.

The fact of licences having been persistently withheld has now had the effect of depressing the export market, and during the past week values have receded to some extent in the near position. The closing quotations are £17 15s. per ton f.o.b. Hull, £17 17s. 6d. f.o.b. Liverpool, and £18 f.o.b. Leith, for September delivery. There has only been a small amount of business passing in the forward position, but producers have maintained a firm attitude in refusing to sell unless they can obtain a premium on prompt prices.

Nitrate of Soda.

The market for this material is still unchanged, and quotations are repeated at 17s. 6d. per cwt. for ordinary quality, and 18s. for refined, on spot.

Sulphate of Ammonia.

From another source, it is stated that to-day's quotations for this article are as follows: Outside London makes, £16 15s.; Hull, £17 12s. 6d.; Leith, £17 15s. to £17 17s. 6d.; Liverpool, £17 15s.; Middlesbrough, £17 12s. 6d.

Notwithstanding the recent outbreak of Fire at our Luton Works, there will be prompt deliveries of the

Davis Domestic "Burn-All"

particulars of which appeared in last week's issue of the "JOURNAL," and should by now be in the hands of the responsible official of every Gas Undertaking in the British Isles.

Send us your early Orders for this new Gas-Seller.

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COAL TRADE REPORT.

Northern Coal Trade.

The coal trade is rather more active; and with a somewhat better export, prices are steadier generally, though the continuance of this improvement depends largely on a fairly full arrival of steamers at our coal ports. In the steam coal trade, there is a fair amount of activity, and the governmental requirements have been larger. Best Northumbrian steam coals may be quoted at about 38s. to 40s. per ton f.o.b. For second-class steams, the current quotation is about 30s. per ton; and steam coals vary in price from 20s. to 25s. per ton f.o.b., the demand being rather better, so as to allow of better shipments, unless tonnage difficulties intervene. The pits are now working better, and the output is well taken up. Forward business seems more promising, but prices are rather more irregular. The gas coal trade is more active, with a fuller inquiry both home and foreign. For prompt delivery, best Durham gas coals are about 32s. per ton f.o.b.; while for forward delivery, the price is a little higher, according to the time needed. Second-class Durhams are quoted at 25s. 6d. per ton; and for "Wear Specials," the price for early delivery is from 34s. to 36s. per ton f.o.b., with a steady demand. Of course, there are large quantities of gas coal being delivered at prices that are below these, and such contracts take up an appreciable part of the production. Freights continue high. Gas coal, Tyne to Genoa, has caused 72s. 6d. per ton to be paid for the sea carriage in the last few days, and 12s. is the rate Tyne to London; so that the fuel delivered is costly when market rates are not controlled. There are rumours as to further governmental control; but this does not seem to be a settled matter yet, and the increasing autumnal demand is being arranged now. Coke appears to be a little more plentiful; but the price is generally firm, and the exports are above those of the corresponding period. Good gas coke is steady, and may be quoted at 33s. to 34s. 6d. per ton f.o.b. Tyne.

Manchester Coal-Tar Products Company.—A private company, bearing this title, has been registered with a capital of £76,000 in £1 shares (38,000 preference), to carry on the business of dye-makers, &c. The first Directors are the Earl of Kintore, C. H. Burr, A. Oddenino, Dr. O. Silberrad, and F. M. Crisp. Mr. A. Oddenino is to be deemed to have been appointed by the holders of a majority of the preference shares, and shall be known as the "preference share director."

Exemption Applications in South London.—Reporting on p. 570 of last week's issue applications to the Camberwell Tribunal for exemption by employees of the South Metropolitan Gas Company, it was stated that, in the case of a service-layer's assistant named E. J. Organ, whose appeal was not supported by his employers, the application was refused. This, Mr. Organ has since informed us, is incorrect—the fact being that he was granted two months' exemption.

Back to the Batswing.

In a column of "Trade Chat," last week's "Ironmonger" had the following: The arguments advanced by some of the gentlemen who are acting as Military Representatives are past understanding. There is a town in the North of England where the manufacture of incandescent mantles has been taken up as a result of the stopping of supplies from Germany. Naturally, such an enterprise called for the services of a chemist; and it is not altogether surprising that the man appointed to this post should be of military age. When the chemist's employers appealed for him, the question was raised whether or not gas-mantle manufacturing was an industry of national importance. The Military Representative argued that, while lighting restrictions were in force, not so many mantles would be required; and that as it was only ten or fifteen years since incandescent lights were first used, the public could, if necessary, very well go back to the old system of lighting. This, in the picturesque slang of the street, is mere "talking out of the back of one's neck." The military gentleman was fifteen years out in his dates; for the Welsbach invention goes back to 1885. He might just as well have suggested the universal re-introduction of rushlights and farthing dips. The old system of which he talks so glibly no longer exists; nor are there men left to revive it.

Revival of Interest in Welsbach Shares.

The following remarks on Stock Exchange activity in the shares of the Welsbach Light Company appeared among the City Notes in last Thursday's issue of the "Evening Standard": "There has been a revival of interest in Welsbachs, which now stand at about 15s. This means that the price has doubled since the last quotation before the war. Obviously, therefore, prospects have been considerably discounted, as the shares are not worth their present price on the basis of the 2½ per cent. dividend paid for the year to March 31 last. The buying, however, has been on the part of investors who are willing to lock the shares away until the end of the war, when, it is contended, they should become more valuable. The Company own 1478 shares of 1000 gulden, representing about £123,600 nominal capital, in the Austrian Company, which, in turn, holds about £165,000 of shares in the Welsbach Light Company. No dividend has been received in respect of this holding since March 31, 1913. The Austrian Company declared 5 per cent. for the year to March 31, 1914; and it is claimed that the British Company will eventually get this. Apart from this speculative item, the Welsbach Company's ordinary business is benefiting from the elimination of German competition. The net revenue nearly doubled in the past year; being £28,500, against £14,600 in 1914-15. Their holding of £19,000 in B Cars Limited is also a good asset; the dividend on this for the year ended March 31 last amounting to £14,600. The Welsbach Company's debenture interest requires only £9540; and the ordinary dividend of 2½ per cent. paid for last year absorbed £6625.

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R. & A. MAIN, LIMITED.

WORKS: Gothic Works, EDMONTON, N.; Gothic Ironworks, FALKIRK; and Gothic Works, BIRMINGHAM.
SHOW-ROOMS AND BRANCHES: 25, Princes Street, Oxford Circus, W.; 136, Renfield Street, GLASGOW; 83, Old Market Street, BRISTOL; 18, Severn Street, Deansgate, MANCHESTER; 97, Millfield, BELFAST; 333, Queen Street, MELBOURNE; and 12, Cunningham Lane, Pitt Street, SYDNEY, N.S.W.

Truro Gas Company.

Mr. John James (the Chairman) presided at the annual meeting of the Truro Gas Company, and moved the adoption of the report, which stated that the profit amounted to £1121, a decrease of £670 as compared with the previous year. This was entirely due to the higher cost of coal and the increased assessment of the undertaking. An appeal had been lodged against the new assessment. The vertical retorts were brought into use in September last, and continued to give very satisfactory results. The Board recommended payment of a dividend of 5 per cent. on the preference shares and 2½ per cent. on the ordinary shares. The Chairman said 70 per cent. of the employees had joined the forces. The cost of coal was £877 more than for the previous year, though they had used 400 tons less. In the last few years, the price of coal had gone up by 14s. per ton; and next year it would be 17s. above the normal, which was equal to 1s. 6d. per 1000 cubic feet of gas sold. There was an increase of 10s. per ton at the pit mouth, which he did not believe was justified by the greater cost of raising the coal. The assessment of the works had been increased by 88 per cent.; and on the basis of this assessment, the rates would be increased by £190, which would represent 3d. per 1000 cubic feet in the price of gas. There was an increase in the revenue of the year by £650. This was due to the increase in the price. In the higher cost of coal, rates, and income-tax, they had an increase in the cost of production of 6½d. per 1000 cubic feet; and the Board had decided to raise the price of gas 6d. Even then, gas would be cheaper than some other commodities; for while coal and oil had doubled in price, gas would be advanced by only 30 per cent. since the war began. They had written-off out of revenue £600 of the cost of the new vertical retorts, and transferred £400 from the renewals fund, making £1000 towards the total outlay. Mr. J. Thomas remarked that 2½ per cent. was a poor return on the capital invested in the Company; and if they had to pay off £1000 a year for the new retort installation, the outlook for the shareholders for the next seven or eight years would not be bright. Mr. S. J. Ingram (the Manager) pointed out that the price of gas was to be increased; and they hoped coal would be cheaper in the not distant future. At the new price gas would be 5s. per 1000 cubic feet, subject to discount. Three years ago it was 3s. 11d. The report was adopted, and the dividends recommended declared.

Stockport Gas-Works Accounts.—Particulars were given on p. 360 of the "JOURNAL" for Aug. 22 from the report of Mr. S. Meunier, the Engineer and Manager of the Stockport Corporation Gas-Works, regarding the working of the financial year ended March 31. The accounts now to hand show that the income on revenue account was £141,956, and the expenditure £109,143, leaving a balance to be carried to the profit and loss account of £32,813. Of this, interest and sinking fund charges account for £19,231; and of the net profit of £13,582, £3332 is transferred to the reserve fund, and £10,250 in aid of the local rates for the year 1916-17.

Women Gas-Men.

In an article in the "Daily Mail," G. Ivy Sanders gives an account of a visit to one of the depôts of the Gas Light and Coke Company, where she saw a number of women gas-stove fitters at work. She says: In a large, airy workshop thirty of them were engaged upon renovating gas-stoves of every description that had been returned from hire. It was indeed "real man's work;" but the manager assured me that in the three months that women have been employed on this particular branch of work, they have become as skilful as their male predecessors. Two men are retained in the "shop" to do the heavy lifting; but the rest of the work is done entirely by women and girls. They dismantle the stoves, which are thoroughly cleansed and purified by burning and washing, then remove all rust and stains, re-fit the burners, and generally overhaul the fittings, taps, and door-handles. The brass work is cleaned and polished, and the stove completely re-painted and re-assembled as fresh and good as new. Watching the girls at work, in their strong, dark blue overalls and caps, with screw-drivers, files, hammers, and various other tools alien to the hands of women, intent, engrossed, and wonderfully efficient upon the arduous work, I realized that yet another fallacy of the inaptitude of women has perished; for opportunity has absolutely destroyed the prevailing theory that women are successfully employed upon repetition work only. Their hours are from 8 to 5.30, with frequent rest intervals. A large room has been set apart for them as a dining or rest-room, and is complete with a small locker for each worker and a gas-stove where they can cook their own food—a concession that appears to be highly appreciated. In other departments women are engaged as messengers, packers, meter-collectors, and demonstrators in the various show-rooms. Their engagement is for the "duration of the war only;" for it has been mutually agreed that the absent men, of whom there are over 3000, shall come into their own again. But on the Roll of Honour that I saw proudly displayed, I saw against all too many a name, a tiny cross that indicates a brave man fallen for his country. Before the Great Day comes, alas! there will be many more such crosses. But those who do return will find that the women, for whom they have been fighting and suffering, have been very conscious of their trust, and kept the home fires burning brightly.

Price of Gas at Matlock Bath.—In consequence of the increased cost of materials, the Matlock Bath Urban District Council have decided to raise the price of gas, as from the 1st prox., 2d. per 1000 cubic feet to ordinary consumers, and 3d. to slot-meter users.

British Mannesmann Tube Company.—The Board of the British Mannesmann Tube Company has now been reconstituted; and the Directors are as follows: Mr. Richard S. Guinness (Chairman), Sir Robert Balfour, M.P., Sir Hugh Bell, and Mr. G. Hethley (Managing-Director). Mr. Hugh W. Dunn will continue to act as Secretary.

ARDEN HILL'S GAS FIRES
FOR 1916-17.

The "GNOME."

We are now supplying all Fires (the "Adept" alone excepted) with only the Patent "Thermo-X" Fire-front, as the "Thermo-X" Radiant has now been so widely adopted as the recognised standard radiant for Gas Fires.

These Fires have also the Patent "Injector-Ventilating" Flues, which ventilate the room as efficiently as the best coal fire.

All our Fires have our Patent Silent Gas-Fire Burner, which, in addition to its absolute silence, also ensures perfect combustion of the gas, as it is adjustable for both Pressure and for Calorific Value, etc. It is Dirt-Proof, and its efficiency is undiminished by any grit from the radiants or grit from firebrick, etc., which may fall into it.

New Season's Price Lists are now ready.

ARDEN HILL & CO.,
Acme Works,
ASTON, BIRMINGHAM.

Public Lighting of Lambeth.

The Finance Committee of the Lambeth Borough Council, reporting on the estimates of the Lighting Committee, state that it was calculated in February last that the net expenditure for 1915-16 would amount to £11,420; but the actual net expenditure was £11,115. The estimated net expenditure for the year ending March 31, 1917, was £12,167. In arriving at the above figures, it was anticipated that the allowance in respect of the modification in lighting would amount to about £2500. Now that figures are available as to the actual number of lamps brought back into lighting in January last, it would appear that, unless the lighting restrictions are further amended, the allowance may not exceed £2200, involving an increase in the new expenditure of the Committee of £300. The Gas Light and Coke Company have recently notified a reduction in the price of gas; but as no increase was made in the schedule charges to the Council when the price of gas was increased to the general public, the Company do not propose to make any reduction in the charge to the Council. The South Metropolitan Gas Company have reduced the price of gas from 2s. 10d. to 2s. 8d. per 1000 cubic feet, and have notified the Council that there will be a corresponding reduction in the present scale charges as from Midsummer last. The probable saving to the Council during the next six months is about £300. The South Suburban Gas Company are not at present making any reduction in the price of gas. The above modifications do not necessitate any alteration in the estimated net requirements of the Committee.

Mirfield Colliery Company.—The Mirfield Colliery Company, Limited, has been registered, with a capital of £60,000 in £1 shares. The offices are at Ravensthorpe, Dewsbury.

The Fatal Explosion at a Camberwell Works.—After an inquiry extending over several days, into the cause of an explosion and fire last July in a Camberwell factory, by which three lives were lost, the Coroner's Jury found that death in each case was due to shock, and that the fire was caused by the bursting of one of three cylinders situated in a corner of the compressing-room. They expressed the opinion that the authorities should reconsider the regulations governing the acetylene industry.

Torquay Gas Company.—The half-yearly meeting of the Company was held last Tuesday—Mr. A. Iredale presiding—when the usual interim dividends of 10 and 7 per cent., less income-tax, were declared. The Chairman said that never had there been such adverse conditions to be faced, as the highest prices on record had been paid for coal, oil, and other materials, and for labour. The Company had been fortunate in maintaining the amount of business done in any corresponding half year; the receipts for the sale of gas being £15,596, against £14,903 last year. The total receipts were £22,672, compared with £21,280. The expenditure was £19,752, against £18,036, leaving a balance of profit of £2920, and enabling the Directors to carry forward a small sum after the payment of the dividends.

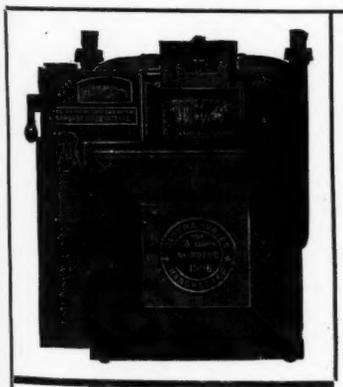
APPLICATIONS FOR PATENTS.

[Extracted from the "Official Journal" for Sept. 20.]

Nos. 12,801—13,191.

Brayshaw, E. R. & S. N.—"Furnaces." No. 12,941.
Cramp, R.—"Valves, cocks, &c." No. 12,890.
Day, A.—"Incandescent burners." No. 13,153.
Doran, W. T.—"Pipes for conveying fluids or gases." No. 12,863.
Evans, E. V.—"Manufacture of sulphate of ammonia." No. 13,063.
Fletcher, C. G.—"Furnaces, coke-ovens, gas-retorts, &c." No. 13,156.
Hardman, G.—"Drilling and tapping machines." No. 13,020.
Hope, A. E.—"Automatic apparatus for obscuring lights." No. 13,032.
Keith, G. & J.—"Crucible furnaces." No. 13 060.
Kilburn, B. E. D.—"Distillation of tar." No. 12,837.
Morison, D. B.—"Indicating difference between two pressures." No. 12,889.
Palmer, W. V.—"Temperature regulators for gas-heated industrial appliances." No. 13,113.
Prockter, F. M.—"Gas-washing apparatus." No. 12,902.
Ringe, A.—"Gas cooking-stove." No. 12,801.
Roots, J. D.—"Incandescent mantle lamps." No. 13,172.
Smulders and Co., L.—"Regulators for gas pumps and compressors." No. 13,151.
South Metropolitan Gas Company.—See Evans. No. 13,063.
South Metropolitan Gas Company.—See Palmer. No. 13,113.
Strassmann, P. G.—"Heating process for producing illuminating gas." No. 13,096.
Sulzer Frères Anon.—See Kilburn. No. 12,837.
Thuman, F.—"Gas-producers." No. 13,178.
Willetts, A. L. & G. F.—"Shades, reflectors, &c." No. 13,180.
Yates, H. J.—"Furnaces." No. 12,941.

Travancore Minerals Company.—Under the provisions of the Trading with the Enemy Amendment Act, 1916, the Public Trustee (Mr. C. J. Stewart) is inviting tenders for the purchase of 10,000 ordinary "A" shares of £1 each, fully-paid, and 19,998 of 7 per cent. cumulative preference shares of £1 each, 15s. paid, in the Travancore Minerals Company, Limited, vested in him as custodian by an order of the Board of Trade. Under the Company's Articles of Association, the transferee must be a natural-born British subject. A report upon the result of the past operations and the present position of the Company has been made by Messrs. Price, Waterhouse, and Co., of No. 3, Frederick's Place, Old Jewry, E.C., and may be inspected by those desirous of tendering, either at the offices of the firm or at those of the Public Trustee, Kingsway, W.C. Tenders must be delivered by the 16th prox., as mentioned in the advertisement columns to-day.



The "Positive"

"THE METER OF MANY MERITS."

SAWER & PURVES, BRANCH OF METERS LTD.

MILES PLATTING, MANCHESTER. RADFORD ROAD, NOTTINGHAM.

Agent for Scotland: JNO. D. GIBSON, 2, CAUSEYSIDE STREET, PAISLEY.

Keighley Water-Works Accounts.—The Mayor showed the Keighley Town Council the week before last that, contrary to the usual conditions, the Water Department was no longer a profit-earning concern, but the reverse. They had been careful in the matter of expenditure during the year; but taxes had increased by £650, general expenses had gone up by £126, and war allowances by £71. There had been decreases in the cost of collection and storage of water to the extent of £475. They had a balance of £812 as a result of over-estimating; and this was to be passed to reserve fund. It was pointed out by a speaker that the reserve fund had increased from £4434 to £5225, and that the really serious matter was the rise in the call on the rates for the water-works. In 1913, the department was self-supporting; but during the past year it had drawn on the rates for £3349, and this would increase, there was no doubt, in the future. The statement of accounts was adopted.

Consequent on the dearth of male labour, four women have been engaged by the Chesterfield Gas and Water Board for the yard at the gas-works. Official report is to the effect that the innovation is quite successful.

At the meeting of the Haverhill Urban District Council last week, the Gas Committee reported that men employed at the gas-works had applied for increases of wages. The Committee recommended that an additional 3d. per shift be granted; and this was agreed to.

The "London Gazette" last week contained a formal announcement by Messrs. Stephenson Clarke and Co., of 4, St. Dunstan's Alley E.C., that they have applied to the Board of Trade, under section 47 of the Merchant Shipping Act, 1894, in respect of the ship *Monkwood* of London, of gross tonnage 1141, and register tonnage 715, for permission to change her name to *Glow*, to be registered at the Port of London as owned by the Gas Light and Coke Company.

During a heavy gale at the beginning of this month, the Wandsworth, Wimbledon, and Epsom District Gas Company's steamship *Mitcham*, with 1500 tons of coal, was driven ashore on the beach at Sheringham. After a hard struggle, the Cromer lifeboat reached the spot; but they found the officers and crew of the vessel, 22 in all, anxious to remain on board until the flood tide. They asked the lifeboatmen to stand by; but later the weather became so much worse that, to save themselves, they decided to abandon their ship. Subsequently, with a large portion of her cargo jettisoned, the steamer was safely got off the beach.

STOCK MARKET REPORT.

THE general course of things on the Stock Exchange last week might be briefly described as uninteresting. Not even the unbroken stream of gratifying dispatches from the various seats of war—enhanced last week by the picturesque item of the "tanks" surprise for the enemy—could galvanize markets into animation even, much less into enthusiasm, and dulness was the prevailing tendency, with a paucity of business as the result. The Committee had resolved to re-open the Exchange on Saturday, in spite of the disapproval testified by a widely-signed petition of remonstrance by members. In result, the attendance was most meagre; and to all intents and purposes the Exchange might just as well have been closed.

Reviewing market movements: The gilt-edged division was in but a poor way generally, and the War Loan showed marked weakness. About the only exception was Consols, which hardened steadily. Rumours and forecasts as to the next War Loan were the motive power. Home Rails were hopeful on the labour question, but did not derive much satisfaction from what is euphemistically called the "settlement." The American Market was stronger, in spite of damaged crops.

In the Foreign Market, the French Loan was strong; but Japanese and Brazilian eased. Argentines were dullish, but South Africans very firm. Among the Miscellanies, rubber revived, and metals and munitions were strong; but oils and textiles were easier.

Business in the Gas Market showed no change. It was just as quiet as it had been the week before; and the prices realized were almost identically the same. Movements in quotations were few, but in the upward direction. Imperial Continental advanced 2, and Primitiva ½.

In the Money Market, there was a good demand, and rates were firm. Discount was quiet and unchanged. Small holders of deposited securities are uneasy in regard to the payment of their dividends, and confidence in Treasury methods of business is not promoted by the confiscation of De Keyser's hotel.

Bargains done for cash during the week were as follows: On Monday, Gas Light ordinary 80¼, Imperial Continental 91, 91⅛, South Metropolitan 84⅜, 85, Tottenham "B" 90, Richmond 5 per cent. 85⅜, 86. On Tuesday, Gas Light ordinary 80, 80¼, 80½, 80¾, Imperial Continental 91, 92, Primitiva 45s., ditto preference 73s. 1½d., 73s. 9d., Tottenham "B" 90¼, 90⅜. On Wednesday, Gas Light ordinary 90⅜, ditto debenture 60⅝, 60⅞, Metropolitan of Melbourne 97⅛, 98, Primitiva 47s., Tottenham "B" 90¼, 90⅜, Reading 5 per cent. 83, 83⅛. On Thursday, Barnet "A" 145, 145½, Gas Light ordinary 80, 80¼, 80⅜, Imperial Continental 91, 93, Metropolitan of Melbourne 98⅛, South Metropolitan 84⅜. On Friday, Bombay 5⅛, Gas Light ordinary 80, 80⅛, 80¼, 80⅜, 80½, 80⅝, 81, Imperial Continental 91, Metropolitan of Melbourne 97½, Primitiva 45s., 46s. 3d., 46s. 10½d., Wimbledon 98, 98⅛. On Saturday, Cape Town 27s., Gas Light ordinary 80¼, Imperial Continental 91, 91⅛, South Metropolitan 84⅛.

The Bank rate is 6 per cent.—as fixed on July 13.

The will has been proved of Mr. W. Yeats Baker, who was a Director of the West Kent Gas Company and also of the Thames Bank Iron Company, at £70,491.

ANTE-WAR PRICES AND DIVIDENDS, LATEST DIVIDENDS, AND LAST WEEK'S BARGAINS.

Issue.	Share.	When ex. Dividend.	Previous Div or Dividend & Bonus.	Last Dividend.	NAME.	Closing Prices. July 30, 1914.	Present Prices.	Lowest and Highest Prices of Bargains.
£			p.c.					
175,479	Stk.	Mar. 10	4	4	Aldershot 4 p.c. Pref.	..	65—70	..
1,551,868	"	April 8	2½	5½	Alliance & Dublin Ord.	59—64	64—66	..
874,000	"	July 10	4	4	Do. 4 p.c. Deb.	76—79	60—65	..
280,000	5	April 29	7½	8/-	Bombay, Ltd.	5⅛—6⅛	5—5⅛	5¼
60,000	10	Feb. 26	18	15/-	Bourne-mouth Gas and Water { 10 p.c.	26—30	25—27	..
333,110	10	"	7	7/-	Bourne-mouth Gas and Water { B ¶ p.c.	15—15½	11—11½	..
115,000	10	"	6	6/-	Bourne-mouth Gas and Water { Pref. 6 p.c.	13½—14	9½—10	..
159,740	—	—	—	4	Bourne-mouth Gas and Water { 4 p.c. Deb.	..	73—75	..
992,045	Stk.	Feb. 26	†14	55/-	Brentford A Consold.	361—366	86—88	..
734,930	"	"	†11	53/9	Do. B New	304—309	83—85	..
55,000	"	"	5	5	Do. 5 p.c. Pref.	109—111	85—90	..
221,400	"	June 11	4	4	Do. 4 p.c. Deb.	91—99	..	..
217,380	Stk.	Feb. 26	11	10⅜	Brighton & Hove Orig.	208—213	165—168*	..
244,200	"	"	8	7⅜	Do. A Ord. Stk.	154—159	121—124*	..
530,000	20	Mar. 26	12½	32/6	British	44—45	35—36	..
120,000	Stk.	June 26	4	4	Do. 4 p.c. Deb. Stk.	88—90	71—73	..
245,771	Stk.	June 26	4	4	Buenos Ayres 4 p.c. Deb.	85—87	60—65	..
100,000	10	—	—	—	Cape Town & Dis., Ltd.	1½—2½	1½—1⅞	27
100,000	10	—	—	4/6	Do. 4½ p.c. Pref.	4—6	4½—5	..
100,000	Stk.	June 26	4½	4½	Do. 4½ p.c. Deb. Stk.	70—75	60—65	..
157,150	Stk.	Feb. 26	5	5	Chester 5 p.c. Ord.	108—110	87½—88½	..
1,513,280	Stk.	Feb. 12	5/9/4	49/4	Commercial 4 p.c. Stk.	106—108	72—74	..
560,000	"	"	5½	46/8	Do. 3½ p.c. do.	108—105	68—70	..
475,000	"	June 11	8	8	Do. 3 p.c. Deb. Stk.	69½—71½	55—57	..
800 000	Stk.	"	4	—	Continental Union, Ltd.	76—79	36—38	..
200 000	"	"	7	—	Do. 7 p.c. Pref.	115—118	55—57	..
278,400	—	—	—	11½	Croydon B and C 7 p.c.	..	175—185	..
—	—	—	—	—	Do. E	..	..	..
492,270	Stk.	—	6	5⅜	Derby Con. Stk.	128—125	100—105	..
55,000	"	—	4	4	Do. Deb. Stk.	102—104	80—83	..
1,002,180	10	July 29	10	7/6	European, Ltd.	17½—18	12½—13½	..
16,313,430	Stk.	Feb. 10	1/17/4	42/-	Gas Light and Coke { 4 p.c. Ord.	98—102	80—81	80—81
2,600,000	"	"	3½	3½	Gas Light and Coke { 3½ p.c. max.	76—79	59—61	..
4,062,235	"	"	4	4	Gas Light and Coke { 4 p.c. Con. Pref.	96—99	73—75	..
4,674,850	"	June 11	8	8	Gas Light and Coke { 8 p.c. Con. Deb.	72½—74½	59—61	60⅝—60⅞
130,000	"	"	10	10	Gas Light and Coke { 10 p.c. Bonds	..	..	..
358,740	Stk.	Mar. 12	5	4½	Hastings & St. L. 3½ p.c.	87—89	78—83*	..
70,000	10	April 29	11	6	Hongkong & China, Ltd.	16½—16½	8—9	
86,600	—	—	—	9½	Hornsey 7 p.c.	..	125—135	..
181,000	Stk.	Mar. 12	7⅛	7⅛	Ilford A and C	151—154	112—117*	..
65,780	"	"	6⅜	5⅞	Do. B	115—119	103—108*	..
65,500	"	June 26	4	4	Do. 4 p.c. Deb.	92—94	73—76	..
4,940,000	Stk.	May 14	9	4½	Imperial Continental	150—160	90 95	91—93
1,235,000	Stk.	Feb. 12	3½	3½	Do. 3½ p.c. Deb. Red.	84—86	65—67	..
295,342	Stk.	Mar. 12	6½	6½	Lea Bridge Ord. 5 p.c.	119—121	87—92	..
2,498,905	Stk.	Feb. 26	10	5	Liverpool 5 p.c. Ord. { A / B	211—218 / 146—148	87—88	..
306,083	"	June 26	4	4	Do. 4 p.c. Pr. Deb. Stk.	..	78½—79½	..
75,000	5	June 11	6	2/-	Malta & Mediterranean	4½—4⅝	4—4½	..
250,000	100	April 1	4½	4½	Met. of Melbourne { 4½ p.c. Deb.	99—101	91—99	97½—93½
541,920	20	May 28	4	6/-	Monte Video, Ltd.	11½—12	8⅜—9½	..
1,875,892	Stk.	July 29	4½	4½	Newc'tle&G'tesh'd Con.	98½—99½	80½—81½	..
529,705	Stk.	June 26	3½	3½	Do. 3½ p.c. Deb.	85—88	75—77	..
55,940	10	Feb. 26	7/14/0	7/8/2	North Middlesex 7 p.c.	14—15	10½—11½*	..
300,000	Stk.	May 14	8	8	Oriental, Ltd.	117—122	108—110	..
60,000	5	Mar. 26	10	1/-	Ottoman, Ltd.	7½—7⅝	2—3	..
60,000	50	Feb. 26	13	60/-	Portsea, Island B	128—131	92—97	..
100,000	50	"	12	55/-	Do. C	118—121	92—97	..
52,000	50	"	10	—	Do. D	..	..	..
249,980	5	April 29	8	—	Primitiva Ord.	5⅛—6	2½—2⅝	45/—47/-
499,960	5	June 26	5	2/6	" 5 p.c. Pref.	4⅞—5	3½ 3⅞	73/1½—73/9
521,600	100	June 2	4	4	" 4 p.c. Deb.	91—93	80—82	..
—	—	—	—	4	" " 1911	..	..	..
346,198	Stk.	June 26	4	4	River Plate 4 p.c. Deb.	85—87	60—65	..
150,000	10	May 14	6	6/-	San Paulo { 6 p.c. Pref.	10½—11	8½—8⅞	..
125,000	50	July 1	5	5	San Paulo { 5 p.c. Deb.	47—49	43—45	..
135,000	Stk.	Mar. 12	10	10	Sheffield A	238—234	188—192*	..
209,984	"	"	10	10	Do. B	232—234	188—192*	..
523,500	"	"	10	10	Do. C	230—232	188—192*	..
90,000	10	May 28	9	10/-	South African	10⅜—11⅛	..	..
6,609,895	Stk.	Feb. 10	5/4/0	44/-	South Met., 4 p.c. Ord.	111—113	83—85	84⅜—85
1,895,445	"	July 10	3	3	Do. 3 p.c. Deb.	72½—74½	59—61	..
224,820	Stk.	Feb. 26	8½	8	South Shields Con. Stk.	167—169	152—154	..
952,795	Stk.	Feb. 26	6	48/4	S'th Suburb'n Ord. 5 p.c.	114—116	80—82	..
60,000	"	"	5	5	Do. 5 p.c. Pref.	110—112	79—81	..
135,000	—	—	—	48/4	Do. West Kent.	..	..	..
187,558	"	June 26	5	5	Do. 5 p.c. Deb. Stk.	116—118	90—92	..
647,740	Stk.	May 14	5	5	Southampton Ord.	99—102	90—95	..
120,000	Stk.	Feb. 12	7½	7½	Tottenham District { A 5 p.c.	135—138	120—123	..
782,275	"	"	6	5¼	Tottenham District { B 3½ p.c.	115—117	90—92	90—90½
181,255	"	June 26	4	4	Tottenham District { 4 p.c. Deb.	87—89	73—75	..
189,380	10	Dec. 26	5	—	Tuscan, Ltd.	5—6	1—2	..
149,900	10	July 1	5	5	Do. 5 p.c. Deb. Red.	93—95	60—65	..
286,476	Stk.	Mar. 12	5	5	Tynemouth, 5 p.c. max.	108½—109½	93½—94½	..
80,000	Stk.	Feb. 26	8⅜	78/9	Wandsworth, Wimbledon, and Epsom—Wandsworth A 5 p.c.	151—156	117—122	..
255,636	"	"	6½	63/9	" B 3½ p.c.	129—134	101—103	..
108,075	"	"	5/17/8	55/1½	" C 3½ p.c.	110—115	88—93	..
352,000	"	"	6½	57/6	Wimbledon 5 p.c.	117—122	93—98	98—98½
98,000	"	"	6⅜	63/9	Epsom 5 p.c.	121—126	98—103	..
88,416	"	June 26	5	5	3 p.c. Deb. Stk.	66—69	53—56	..

* Ex. Div. † Paid on Old 10 p.c. and 7 p.c. Standard Stocks.